

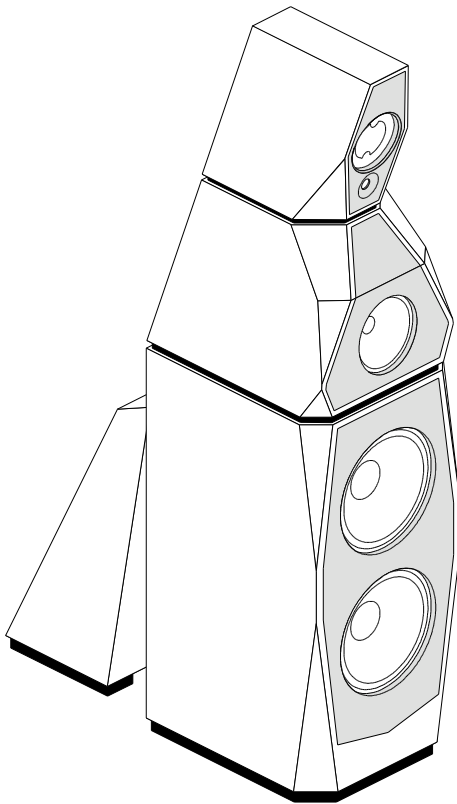


MUSICAL MASTERPIECES

SENTINEL

Serial Numbers _____

Handcrafted by:



This product is certified to meet the requirements of the European Union (EU) Electromagnetic Compatibility (EMC) Directive (89/336/EEC). Because the permanent magnets attached to the loudspeaker drivers produce magnetic fields, it is recommended that the product not be positioned in very close proximity to computer monitors or television sets.

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1 Introduction

Overview

The Avalon Acoustics Sentinel Active Reference System represents the application of edge-of-the-art loudspeaker technology in every area of high accuracy transducer development. New research in diaphragm materials, magnetics, low-noise circuitry, resonance control, and temporal coherence, never before employed in high energy transducers, redefines the boundaries of music reproduction. The intent has been to create a full range transducer capable of high-energy transfer that behaves like a small array with point-source accuracy.

The Sentinel accomplishes this goal by lowering the noise floor and eliminating stray energy, thereby preserving timing detail, transient accuracy, natural instrumental timbre, and stage presentation while providing transparency, clarity, and detailed focus up and down the frequency spectrum. Powered by a dedicated high-energy subwoofer amplifier, Sentinel actively controls and realistically renders low frequencies, down to 16 Hz, while maintaining transient accuracy and harmonic integrity. Truly an Active Reference System, the Sentinel re-creates musical events in a manner that is uncompromised and sonically neutral.

Your Sentinel is designed and built to the highest standards of workmanship and performance. These standards are preserved through the test of time by careful attention to component quality and meticulous testing of each unit before leaving the factory. As a new owner of this Avalon Acoustics product, you can be assured that you possess one of the few great loudspeakers the audio industry has to offer.

1.1 Low Noise Floor

A key element in achieving the sonic goals mentioned in the previous section is significantly reducing the noise floor. The term "noise floor," in this discussion, refers to the stray uncorrelated energy that is produced as an artifact by the loudspeaker. This manifests itself in latent energy below the musical signal and in deleterious phase noise. Both must be reduced to an absolute minimum.

Through new proprietary technologies in the elements of the crossover circuitry, the noise floor has been lowered by more than 25 dB over any existing design. The low noise principle has also been applied to cabinet design and construction, where new techniques in resonance control and careful attention to diffraction and driver coupling effects further reduce stray acoustic energy.

The overall sonic result is a three dimensional spatial presentation of the instruments recorded within the context of their original environment. The background seems black and devoid of contaminating energy, while each individual instrument breathes into the space in which it was recorded. Truly low level details, such as wall reflections from the original recording site, are clearly and concretely apparent. The entire recording environment, whether natural or artificial, can now be transposed *in toto* to your listening room.

1.2 Coherent Energy Transfer

Coherent energy is both an aspect of the absolute quantity of energy, and also the speed with which that energy begins and ends. Entirely new technologies in current transfer and in magnetic field energy storage within the crossover maximizes the transient speed of the transducer, while eliminating the ringing that can give recorded music a fatiguing and etched quality.

Dynamic measurement techniques provide prediction of circuit behavior under actual musical conditions. Through these techniques, current saturation effects throughout the system are greatly reduced. Proper phasing of elements within the crossover circuitry is now achievable. With these new technical developments, the level of inter-driver jitter (mis-timing between drivers) can be virtually eliminated.

The sonic results of this technology are stable, tightly focused images that retain their position and harmonic structure, regardless of input intensity (provided, of course, that the chain of amplification is able to deliver the quantity of energy required with great speed). The most apparent benefit of coherent energy transfer is in the rendering of bass information. Low frequencies are delivered with a clarity that reveals the subtle harmonic structure of pipe organ and bass guitar passages, while precise timing provides a coherent temporal structure throughout the frequency spectrum.

1.3 The Active Reference System

A definitive transducer project of this magnitude demands the holistic integration of diverse design goals, including perfect phase response, critical damping, and point source accuracy. In addition, horizontal dispersion must be uniform across the frequency spectrum in order to generate a coherently focused wavefront and minimize room interaction artifacts. The difficulty of integrating all of these elements increases exponentially as the size of the array grows larger. It is only through complex computer modeling, meticulous physical and electrical alignment, and scores of hours of dedicated listening that correct phase response, without restricting the frequency response, has been achieved. The result is a transducer that is extremely revealing of microphone placement and phasing techniques from the recording site. The most subtle ambient information is clearly apparent. There is no exaggeration of details over fundamental elements of the recording; context is always clearly maintained.

These qualities are most apparent when using the Sentinel Active Reference System as an evaluation tool. Amplifiers, for example, that were previously thought to have similar sonic characteristics are now definitively separated by their individual signatures. The system's smooth non-reactive impedance response insures that the sound of an amplifier is not due to an interactive effect, but is a true representation of its sonic fingerprint. By ameliorating many of the technical shortcomings of all previous transducers, the music lover moves closer to the performance and the intent of the artist. Similarly, the critical evaluator now has a transparent window through which the differences between the elements under test (e.g. amplifiers, cartridges, etc.) can be clearly discerned.

2 Unpacking Instructions

Introduction

Your Avalon Acoustics loudspeakers and sub amplifiers were shipped in seven heavy-duty crates to ensure their safe arrival. It is recommended to save these crates and boxes for possible future use. Due to the weight of the system, the listening room floor structure must be extremely robust and reliable.

WARNING: The Sentinel Active Reference System weighs over 1,100 pounds (approximately 520 kg). You MUST evaluate and verify the integrity of the intended listening room floor structure before bringing the crates into the home.

In addition, it will require three persons to un-crate them and position them for listening. Please arrange for your dealer and/or other friends to assist in this project.

CAUTION: Three people are required for unpacking and set-up. To avoid injury, do NOT attempt to unpack or set-up by oneself.

Contents

There are six Sentinel loudspeaker cabinets and two subwoofer amplifiers packaged as follows:

- Two upper loudspeaker cabinets in two crates
- Two lower loudspeaker cabinets two crates
- Two crossover cabinets in one crate
- Two subwoofer amplifiers in two crates

One of the crates also contains twenty threaded Apex[®] Couplers, two set-up blocks, one 7/16" - 1/2" open end wrench, one 5/32" hex wrench, and this owner's manual.

2.1 Room Preparation and Verification

The Sentinel Active Reference System weighs over 1,100 pounds (about 520 kg). It is therefore crucial to verify the soundness of the intended listening room floor structure and to insure that the structure can safely support the device. If the listening room is not located on the ground floor, and/or if the floor structure is suspended, it is recommended that you consult a structural engineer for assistance.

WARNING: The Sentinel Active Reference System weighs over 1,100 pounds (approximately 520 kg). You MUST evaluate and verify the integrity of the intended listening room floor structure before bringing the crates into the home.

The Sentinel is a full-range frequency device capable of accurately reproducing the deep bass of a pipe organ or large bass drum. Any loose items within the listening room (such as picture frames, light fixtures, drapery controls, etc.) can easily become excited and resonate when the transducer reproduces these very low frequencies. In order to avoid these vibration effects, care should be taken to secure loose items or remove them from the listening environment.

2.2 Crate and Box Placement for Unpacking

Because of the weight and size of the Sentinel Active Reference System, it is important to plan the layout of your room and carefully place the crated devices within the listening environment BEFORE unpacking. Should you require assistance with planning your listening room, please refer to the in-depth discussion in Chapter 9, Room Acoustics and Speaker Position (beginning on page 41). If you require additional assistance, contact your dealer or phone the factory.

CAUTION: Three people are required for unpacking. To avoid injury, do NOT attempt to unpack by oneself.

Once the room placement plan has been established, bring the crated system into the listening room and place them according to the following guidelines (see Figure 2.1):

- Sub Speaker crates at the back wall, behind the final speaker position.
- Sub Amplifier crates at the back wall, inboard of the sub speaker crates.
- Top Speaker crates near the listening position.
- Crossover crate at the back wall between amplifier crates.

IMPORTANT: Place the crates of one channel with matching serial numbers on one side of the room, opposite the crates of other channel.

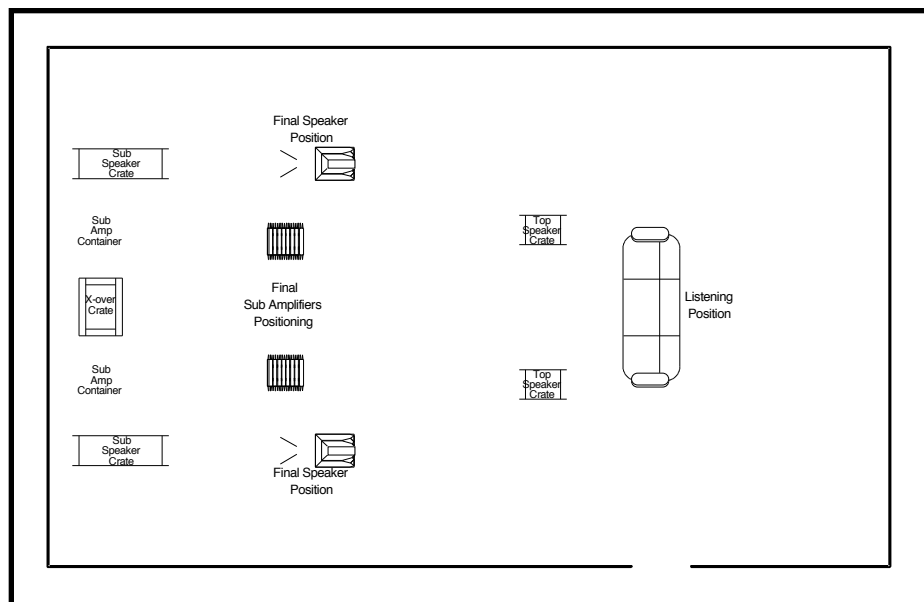


Figure 2.1 - Room set-up for unpacking.

2.3 Opening the Crates

All of the crates features a one-piece top assembly which is fastened to the crate bottom with screws around the lower perimeter.

To unpack the crossovers, remove the screws and lift the upper portion of the crate straight up (this will require two people). Carefully lift the cabinets by the small overhang at the base. See Figure 2.2.

CAUTION: Three people are required for unpacking. To avoid injury, do NOT attempt to unpack by oneself.

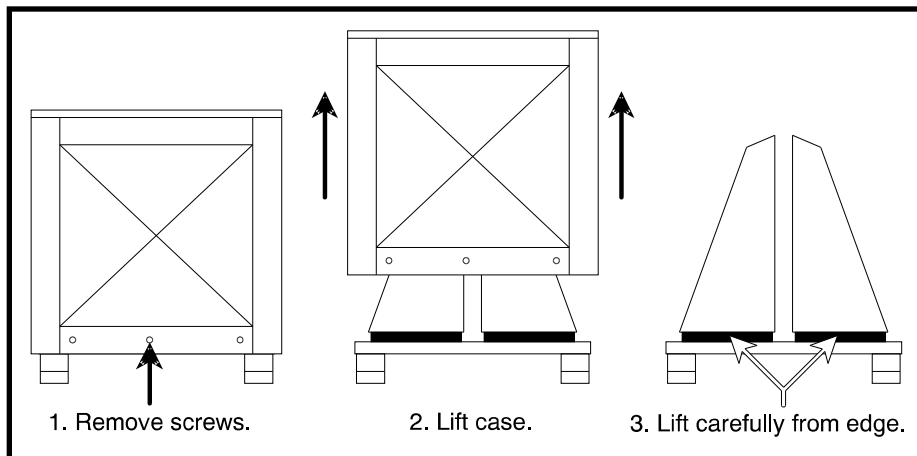


Figure 2.2 – To unpack the crossover cabinets..

To unpack the upper speaker cabinets, remove the screws and lift the upper portion of the crate straight up (this will require two people). Carefully lift the cabinets by the small overhang at the base. See Figure 2.3.

CAUTION: Three people are required for unpacking. To avoid injury, do NOT attempt to unpack by oneself.

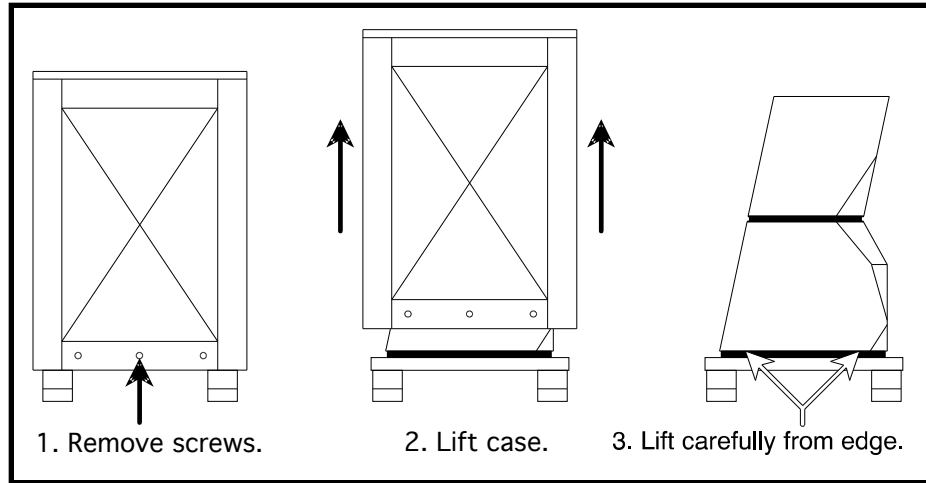
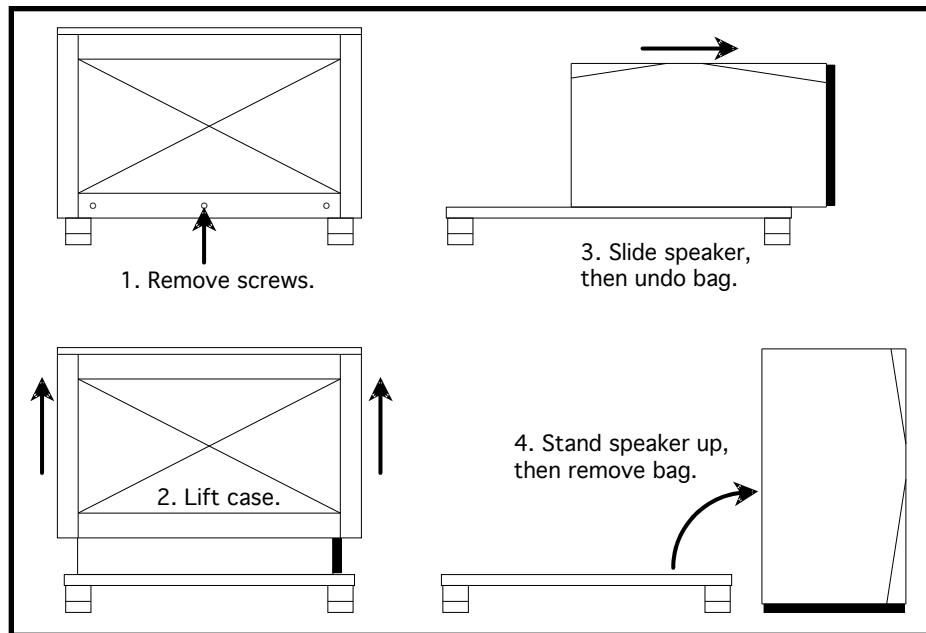


Figure 2.3 – To unpack the upper speaker cabinets..

To unpack the lower speaker cabinets, first remove the top of the crate. Then slide the speaker part way off of the crate base so that the plastic bag can be unfastened from the enclosure bottom. Stand the speaker up and the bag can be slid off the top. Please refer to Figure 2.4.



2.3 Opening the Sub Amplifier Crates

The Subwoofer Amplifiers are also packed in heavy-duty crates. To unpack, remove the screws and lift the upper portion of the crate straight up (this will require two people). Carefully lift the amplifiers off of the crate base. Take it out of the plastic bag and check to ensure the following has also been included:

- One (1) detachable AC linecord
- Nut driver for output connectors

3 System Set-up

WARNING: Failure to follow the set-up and wiring instructions explicitly may cause damage to your loudspeakers and void your warranty.

Preparation

In order to begin system set-up, it is important that all materials are unpacked and all cabinets are removed from the crates in accordance with Chapter 2, Unpacking Instructions, beginning on page 9. Then remove all the empty crates from the listening room to provide for additional assembly space.

Removing Apex[®] Couplers from Set-up Blocks

Figure 2.4 – To unpack the lower speaker cabinets..

Remove all twenty Apex[®] couplers from the two set-up blocks (see Figure 3.1). Three couplers will get installed in each of the six cabinets. Use the 1/2" open end wrench on the wrenching flats to loosen as required.

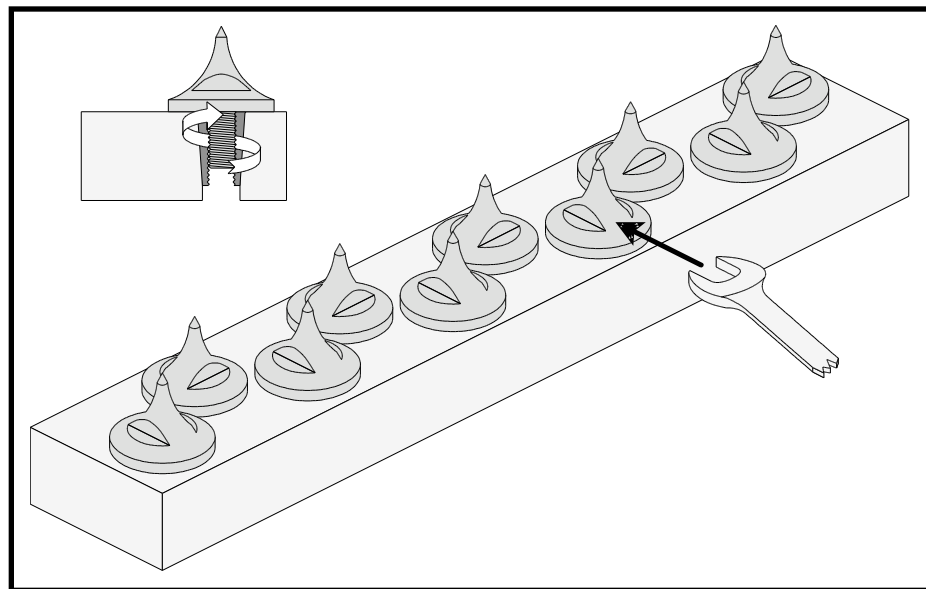


Figure 3.1 – Removal of Apex[®] Couplers.

Left / Right Channel Matching

The two system channels (left and right) are consecutively serialized at the factory. The elements of each channel are matched as a set for both their electrical and aesthetic characteristics. Therefore, it is important to keep the three cabinets of one channel (upper speaker, lower speaker, crossover) which are labeled with the same serial number together on one side of the room, separate from the three cabinets of the other channel.

IMPORTANT: Set-up the three cabinets of one channel with matching serial numbers together on one side of the room, opposite the three cabinets of other channel.

The serial number on the crossover cabinet is printed on the nameplate on the bottom of the cabinet. The lower speaker cabinet has a serial number label located on the top, near the back of the cabinet, and the upper speaker cabinet has a serial number label located on the bottom, near the back of the cabinet.

3.1 Lower Speaker Cabinet Set-up

CAUTION: Three people are required for the set-up procedure. To avoid injury, do NOT attempt to set-up by oneself.

1. Carefully lift and place each lower speaker cabinet in its measured final location, as it becomes more difficult to move once the Apex[®] couplers are attached. Carefully route the sub's integral wiring between the legs of the cabinet base, thereby protecting the wiring harnesses from becoming pinched.

WARNING: The wiring harnesses are fragile and can be easily damaged by pinching them beneath the cabinet base.

2. Lay the speaker on its side, using a blanket or other soft material to avoid scratching the finish.

3. Install three Apex[®] couplers on the bottom of the cabinet by fastening the threaded ends of the couplers into the cabinet inserts (see Figure 3.2). Lightly tighten the couplers and insure that the base of the coupler contacts the bottom of the recess.

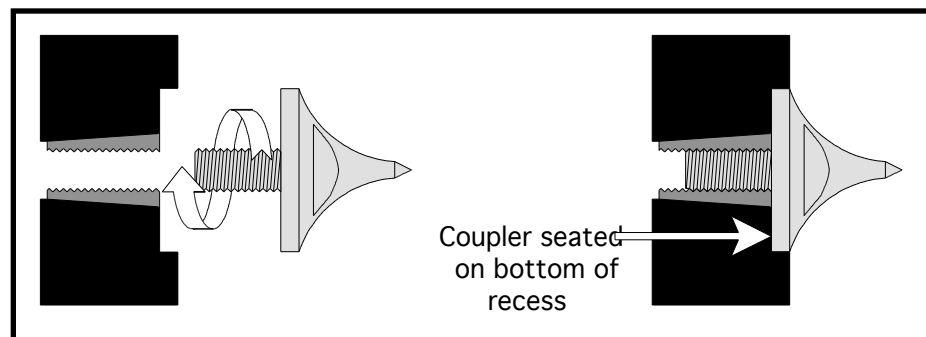


Figure 3.2 – Installation of Apex[®] couplers.

4. Stand up the cabinet, again carefully routing the wiring harness to prevent it from becoming pinched.

5. Measure and adjust the location of the cabinet within the listening room. The cabinet should be set in place with a minimum of toe-in (no more than two or three degrees).

3.2 Upper Speaker Cabinet Set-up

CAUTION: Three people are required for the set-up procedure. To avoid injury, do NOT attempt to set-up by oneself.

1. Lay the upper speaker on one side, using a blanket or other soft material to avoid scratching the finish.
2. Install three Apex[®] couplers on the bottom of the cabinet by fastening the threaded ends of the couplers into the cabinet inserts (see Figure 3.2). Lightly tighten the couplers and insure that the base of the coupler contacts the bottom of the recess.
3. Stand up the cabinet. Carefully route the integral wiring between the legs of the cabinet base, thereby protecting the wiring harness from becoming pinched.

WARNING: The wiring harnesses are fragile and can be easily damaged by pinching them beneath the cabinet base.

4. Place the two supplied set-up blocks on top of the **lower** speaker cabinet, taking care NOT to cover the sockets or wiring guide tubes, as shown in Figure 3.3. The set-up blocks prevent scratching of the lower speaker cabinet during positioning and alignment.

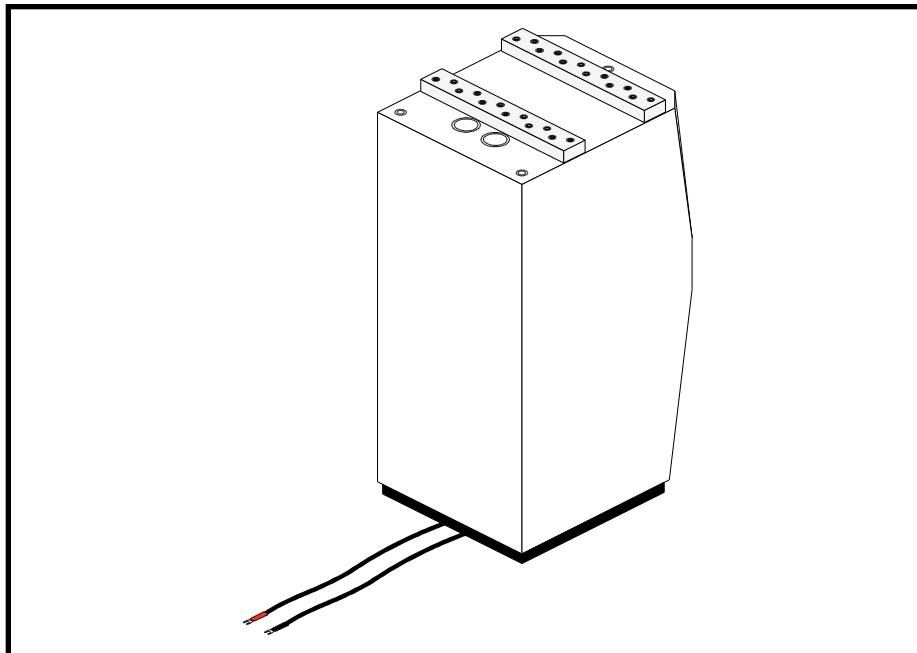


Figure 3.3 – Placement of set-up blocks atop lower speaker cabinet. Do NOT cover the receiving sockets or wiring tubes with the set-up blocks.

5. Carefully lift each upper speaker cabinet by the small overhang at the base, and place it directly on top of the lower speaker cabinet, with the set-up blocks between them. Then gently slide the upper cabinet slightly forward to expose the wiring tubes in the lower cabinet (See Figure 3.4).

6. Route the upper speaker cabinet wiring through the wiring tubes and out the bottom rear of the lower speaker cabinets, as shown in Figure 3.4.

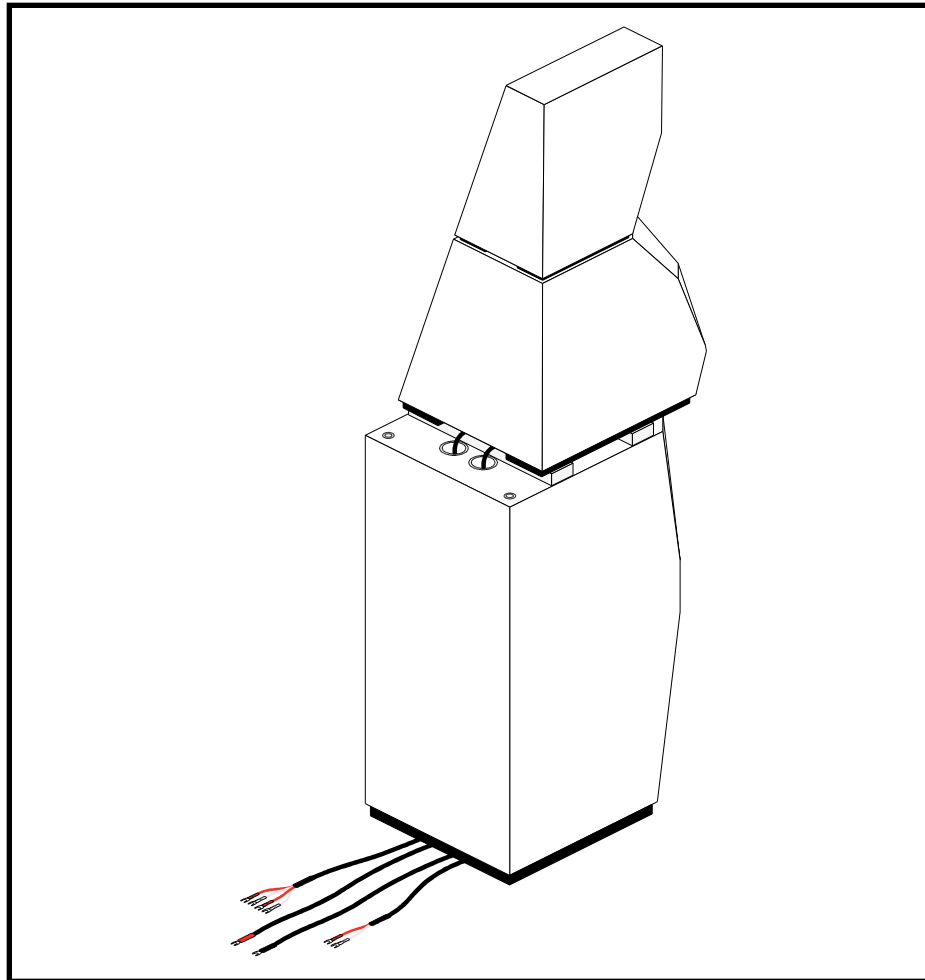


Figure 3.4 – Placement of upper speaker cabinet atop lower speaker cabinet. The upper speaker cabinet is slid forward to allow for routing of the upper speaker cabinet wiring through the wiring tubes.

6. Once the wiring is routed through the wiring tubes, slide the upper speakers cabinets back, so that the couplers on the upper speaker cabinet are **directly above the sockets** on the lower speaker cabinet (see Figure 3.5). If necessary, gently adjust the upper speaker cabinet on the set-up blocks.

7. Remove the set-up blocks (refer to Figure 3.5): Lift the back side of the upper speaker cabinet slightly, freeing the rear set-up block. Remove the rear set-up block, and carefully lower the two rear Apex Couplers into their respective receiving sockets. Then lift the front side of the upper speaker

cabinet slightly, remove the front set-up block, and lower the single front Apex
□ Coupler into its receiving socket.

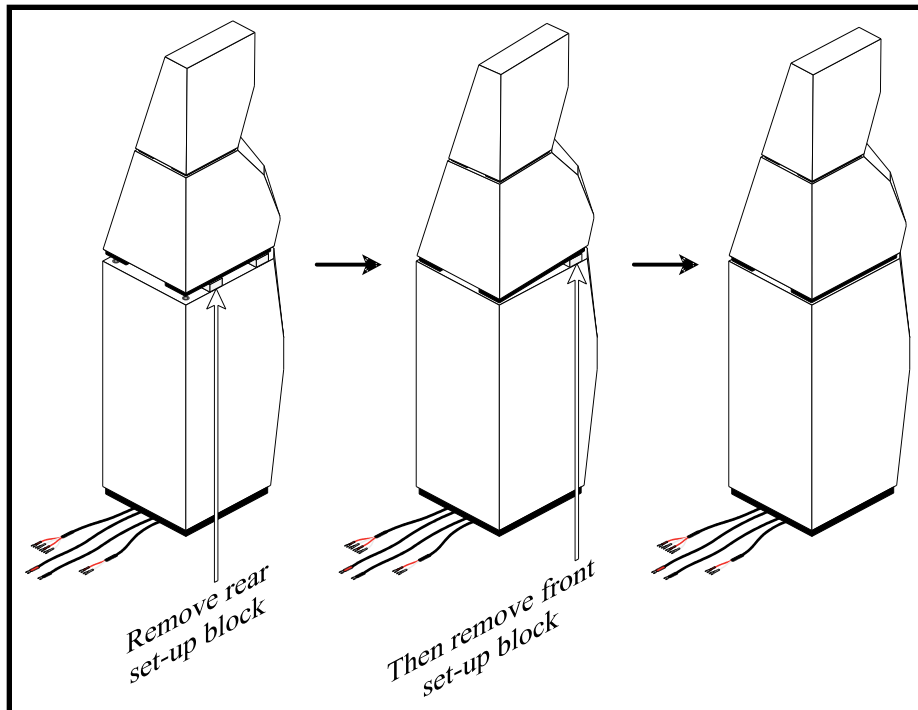


Figure 3.5 – Removal of the set-up blocks between upper and lower speaker cabinets.

3.3 Crossover Cabinet Set-up

CAUTION: Three people are required for the set-up procedure. To avoid injury, do NOT attempt to set-up by oneself.

1. Lay the crossover cabinet on one side, just behind the speaker cabinet, using a blanket or other soft material to avoid scratching the finish. The cabinet should be oriented so that output terminals are adjacent to the back surface of the speaker cabinets (see Figure 3.6).

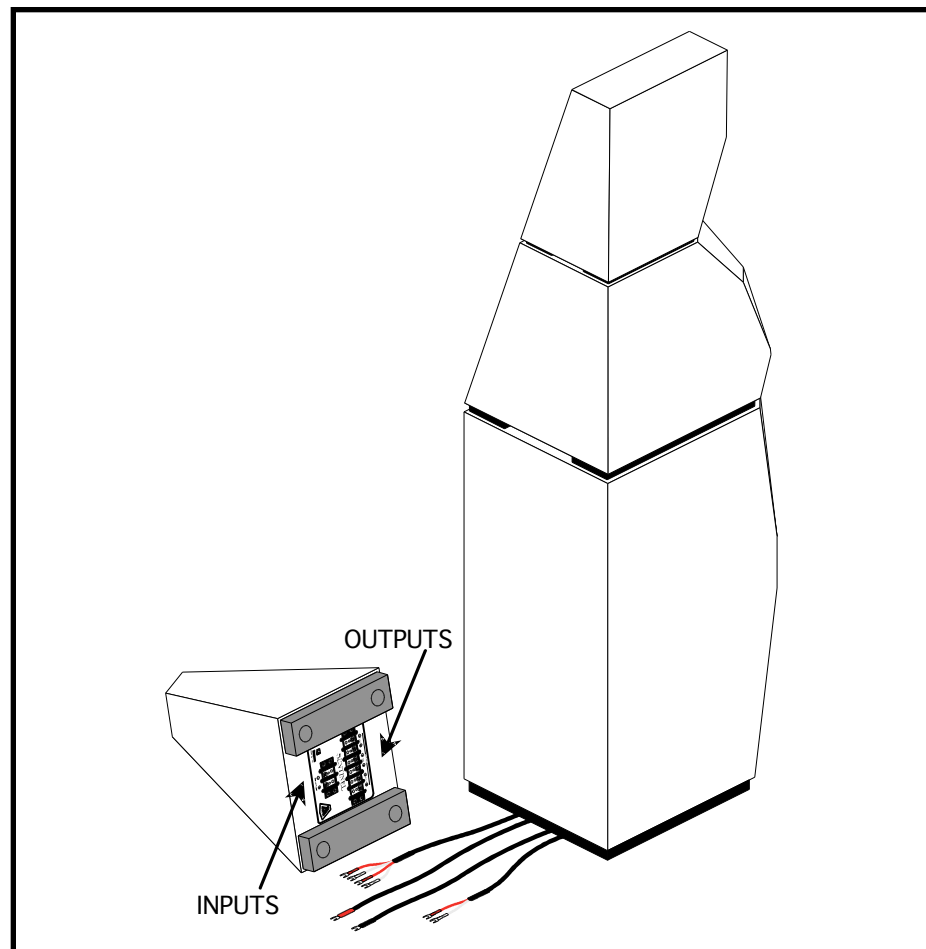


Figure 3.6 – Proper placement of crossover cabinet behind speaker.

2. Install four Apex[®] couplers on the bottom of the cabinet by fastening the threaded ends of the couplers into the cabinet inserts (see Figure 3.2). Lightly tighten the couplers and insure that the base of the coupler contacts the bottom of the recess.
3. Do NOT stand up the crossover cabinet at this time, as you will need to connect upper speaker harnesses to the output terminals in Section 4.

3.4 The Felt Anti-Diffraction Mask

The anti-diffraction masks are installed at the factory, and fit within the recesses on the cabinet face. It is very important that the felt mask make physical contact with the face of the loudspeaker, as air space between the felt and the speaker face will adversely affect sound quality.

Orientation of the upper Felt Mask

Should the felts come loose from the cabinets during shipping, remember to reinsert them, as they are critical to loudspeaker performance. The upper felt is beveled around the openings for the tweeter and midrange drivers. Be sure to note the correct inside-outside orientation when installing it. The driver openings are beveled on the side that faces the listener (away from the speaker). Figure 3.7 displays the proper installation. Apply gentle pressure to the felt where it touches the adhesive tape strips, while taking care not to damage the transducer diaphragms.

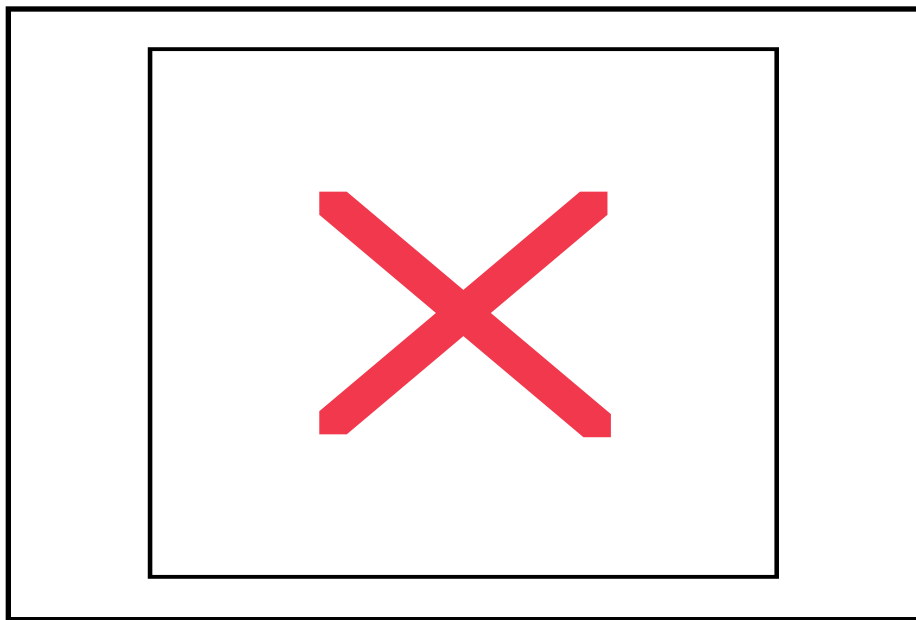


Figure 3.7 – Proper orientation of the upper Felt Mask.

WARNING: The transducer diaphragms are very fragile and are easily damaged. Do NOT touch the diaphragms while positioning and installing felts.

3.5 Sub Amplifier Set-up

Place the Sub Amplifiers in their final set-up positions, allowing 8 inches at the rear for tightening the speaker output connectors.

The power transformer in the Sub Amplifier is located at the front-center of the unit. Ideally, a few feet should separate this area from components which potentially could pick up hum. These include preamplifiers, turntables, and interconnect cables. In terms of providing adequate airspace for cooling, a good rule of thumb is to allow 6 inches above and 3 inches on each side of the unit.

4 Wiring Instructions

WARNING: Failure to follow the set-up and wiring instructions explicitly may cause damage to your loudspeakers and void your warranty.

Introduction

The Sentinel crossover is designed specifically for use with the drivers in the upper speaker cabinet. The crossover is housed in a separate enclosure, designed to be placed directly behind the speaker. Input to the upper speaker cabinet drivers is facilitated by a two-position terminal block, using your own speaker cable, and is for **SINGLE-WIRING ONLY**.

By contrast, the lower speaker cabinet is actively powered by, and directly connected to the subwoofer amplifier. Wiring between the subwoofer amplifier and subwoofer drivers is hard-wired to the subwoofer drivers.

The external crossovers must be used at all times for the upper speaker cabinet drivers. The subwoofer amplifier powers the subwoofer drivers ONLY. Do NOT connect the subwoofer amplifier (or your own amplifier) directly to the upper speaker cabinet drivers.

Because of the weight and size of the Sentinel Active Reference System, it is important to complete the set-up procedure before making wiring connections (see Chapter 3, System Set-up, beginning on page 15).

Connections from the upper speaker cabinet to the crossover cabinet is made by two wiring harnesses: a four-conductor wiring harness with labels "HIGH" and "MID" for the tweeter and midrange, and a two-conductor wiring harness with labels "LOW" for the woofer. These harnesses are hard-wired directly to the upper loudspeaker cabinet drivers (routed through the wiring tubes in the lower speaker cabinet), in order to provide the most unobstructed signal path.

Connections from the subwoofer cabinet to the subwoofer amplifier are made by a two-conductor wiring harness with labels "SUB". This harness is hard-wired directly to the subwoofer cabinet drivers in order to provide the most unobstructed signal path.

The Sentinel Active Reference System is equipped with nickel-plated brass barrier terminals for connecting the harnesses and speaker cables. Ring terminals or spade lugs designed for #10 screws are recommended for cable termination.

Do NOT over-tighten the screws.

4.1 Wiring and Field Interactions

The Sentinel Active Reference System is an extremely revealing, high-energy device. Therefore, it is important to carefully plan the placement and routing of wires when setting up your music reproduction system. Wiring is a task that is often performed in a quick and haphazard manner, driven by the excitement and anticipation of listening to one's brand new system. Although it is compelling to rush into this process, **don't rush!**

Inductive field effects

The wiring in your music reproduction system is a very sensitive network of electromagnetic conductors. Any changing magnetic fields that are in close proximity to those conductors will induce small contaminating signals, thereby degrading the music fidelity. In addition, the magnetic fields generated by signals passing through one conductor will induce similar contaminating signals in any adjacent conductors. These cross-inductive effects in a poorly laid-out conductor network substantially increase the system noise floor, resulting in a lack of image focus and resolution. In severe cases, oscillative phenomena may also have disastrous effects on wide bandwidth amplifiers.

The following guidelines will minimize inductive field effects in your system:

- Physically separate the conductors whenever possible, as cross-inductive effects decrease with the square of the distance between elements. This applies to speaker cable, interconnects, digital cables, and any AC cables in your system.
- When crossing of wires is unavoidable, cross them at right angles to one another, and place non-conductive spacers between them.
- Avoid placing magnetic field devices near the conductors. Devices such as halogen lights, fluorescent lights, dimmer switches, terminator boxes, or computer equipment should not be placed in the vicinity of the wiring or crossovers.

4.2 Connecting Upper Speaker Cabinet to Crossover

1. Locate the upper speaker cabinet wiring harnesses: a four-conductor wiring harness with labels "HIGH" and "MID" for the tweeter and midrange, and a two-conductor wiring harness with labels "LOW" for the woofer. These harnesses are hard-wired directly to the upper loudspeaker cabinet drivers (routed through the wiring tubes in the lower speaker cabinet), in order to provide the most unobstructed signal path.
2. Connect the upper speaker cabinet wiring harnesses (routed through the wiring tubes in the lower speaker cabinet) to the **OUTPUT** terminal block on the bottom of the crossover cabinet, as shown in Figure 4.1.

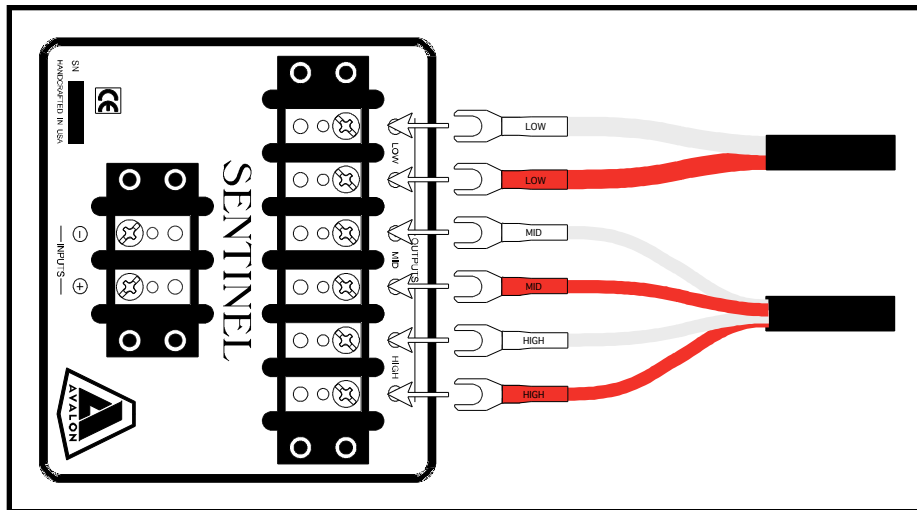


Figure 4.1 – Connecting the upper speaker cabinet wiring harnesses to the crossover. RED is positive (+) and WHITE is negative (-).

Do NOT over-tighten the binding posts.

3. Check to insure the correct polarity: The spade with the RED label connects to the positive (+) terminal, and the spade with the WHITE label connects to the negative (-) terminal.

IMPORTANT: Correct polarity of connections is critical to performance. Check to insure that the RED labeled spade is connected to the positive (+) post and the WHITE labeled spade is connected to the negative (-) post.

4. Check to insure the correct driver connections: The spades with the "LOW" label connect to the terminals labeled "LOW", spades with "MID" connect to terminals with "MID", and spades with "HIGH" connect to terminals with "HIGH".

WARNING: Improper connection of drivers to crossover sections may instantly destroy the drivers in question. Check all connections carefully BEFORE power-up.

4.3 Connecting Speaker Cable to the Crossover

1. Locate the input terminal block on the bottom of the crossover cabinets. Route your own SINGLE-WIRED speaker cables to these INPUT terminals.
2. Connect your own speaker wires (for the upper speaker cabinet drivers) to the **INPUT** terminal block on the bottom of the crossover cabinet, as shown in Figure 4.2.

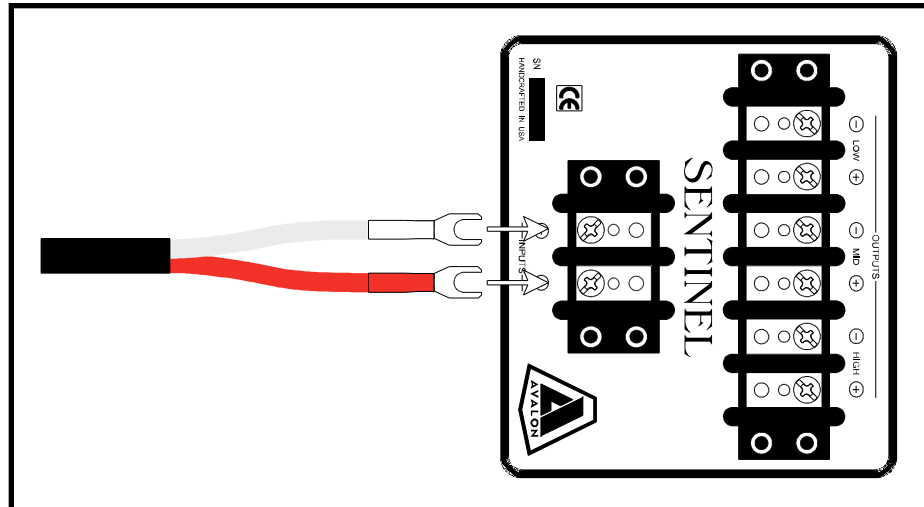


Figure 4.2 – Connecting your speaker cables to the crossover. Make sure to check the polarity of the connections.

Do NOT over-tighten the binding posts.

IMPORTANT: Correct polarity of connections is critical to performance. Check to insure that the polarity is correct at both the amplifier and crossover cabinet terminals.

3. At this point you may stand up the crossover cabinet, leaving a minimum of several inches between the crossover and speaker cabinets to avoid possible collision and damage. Also take care to route the wiring between the legs of the cabinet bases, thereby protecting the wiring harnesses from becoming pinched.

WARNING: The wiring harnesses are fragile and can be easily damaged by pinching them beneath the cabinet base.

4.4 Connect Speaker Cable to your Amplifier

Although it is possible to power the Sentinel Active Reference System with a single stereo amplifier, it is recommended to separate the amplification into left and right channels. This is accomplished by using two mono amplifiers.

Separating the left and right channel amplification eliminates amplifier inter-channel modulation due to the amplifier's finite output impedance and aids in preserving the Sentinel's pristine phase relationships. Cross coupling effects between the channels are minimized, thereby maintaining proper stage width presentation. Isolating the power supply signals also allows better noise rejection, resulting in improved focus, dynamics, and low-level detail.

When using two mono amplifiers, the Sentinel Active Reference System external crossovers MUST be used.

For powering the upper speaker cabinet drivers, your amplifiers are driven with a full-range signal from the pre-amplifier, and the frequency division is performed by the passive crossover.

Use of active (electronic) crossovers for the Upper Speaker cabinet drivers will result in inferior sound quality and may damage the drive units.

When using two mono amplifiers, it is important that they are identical units. It is also important to be aware of the absolute polarity of the amplifiers. If the amplifiers invert phase, be sure to compensate by reversing the polarity of the speaker leads at the amplifier's output terminals.

4.4 Connecting Subwoofer to the Sub Amplifier

1. Locate the lower speaker cabinet wiring harnesses: two single-conductor wiring cables with the label "SUB". These harnesses are hard-wired directly to the lower loudspeaker cabinet sub drivers, in order to provide the most unobstructed signal path.
2. Connect the lower speaker cabinet wiring to the **OUTPUT** connectors on the back of the sub amplifier.
3. Check to insure the correct polarity: The spade with the RED label connects to the positive (+) terminal, and the spade with the WHITE label connects to the negative (-) terminal.

IMPORTANT: Correct polarity of connections is critical to performance. Check to insure that the RED labeled spade is connected to the positive (+) post and the WHITE labeled spade is connected to the negative (-) post.

WARNING: Improper connection of drivers to crossover sections may instantly destroy the drivers in question. Check all connections carefully BEFORE power-up.

4.5 Connecting Preamplifier to the Amplifiers

The Sentinel subwoofer section is actively powered by its own subwoofer amplifier, whereas the upper speaker section is powered by your own amplifier that is directly connected to the Sentinel crossover cabinet. Therefore, you will need to make **two separate output connections from your preamplifier**. This is accomplished in one of the following three methods:

1. Interconnect Y-cable at the preamplifier

A high-quality interconnect Y-cable may be the method with the least amount of signal loss. Simply connect Y-cables directly at the preamplifier's left and right channel outputs to divide the signals, resulting in two left channel outputs and two right channel outputs. Then route one set of divided outputs (right and left channel) to the subwoofer amplifier, and the other set (right and left channel) to your own amplifier.

2. Two outputs at the preamplifier

Some preamplifiers are equipped with two sets of outputs. In this case, you may simply connect one set of outputs (right and left channel) to the subwoofer amplifier, and the other set of outputs (right and left channel) to your own amplifier. If the preamplifier inverts the phase of one of the outputs, be sure to compensate by reversing the polarity of the speaker leads at the corresponding amplifier's output terminals.

IMPORTANT: Correct polarity of connections is critical to performance. Check to insure that the polarity is correct at the amplifier and crossover cabinet terminals.

3. Loop-Out from the Subwoofer Amplifier

The Sentinel Subwoofer amplifier is also equipped with loop-output connectors that bypass the amplifier's circuitry. Utilizing this feature, you may connect directly from these subwoofer amplifier loop-outputs to the inputs of your own amplifier.

WARNING: Failure to follow the set-up and wiring instructions explicitly may cause damage to your loudspeakers and void your warranty.

5 Break-in Period

Your new Avalon Acoustics Sentinel Active Reference System has an initial break-in period. It will not perform to its full sonic potential when first installed in your system. This is due to a residual polarization of the dielectric materials used in the crossover capacitors and internal wiring.¹ As music is played through the loudspeakers, the electrical signal will gradually anneal these materials. Similarly, the suspensions of the drivers will reach their optimal mechanical properties as the speakers are played. Only after the break-in period will the full performance of your Avalon Acoustics loudspeakers be realized.

The break-in process will occur naturally as music is played through the system. To reduce the time required, it is recommended that the system be played continuously, using either a digital source in the repeat mode or an FM broadcast signal. The recommended break-in procedure is as follows:

- Initial warm-up: three to six hours of quiet music.
- Extended break-in: 200 to 300 hours of loud and dynamic source material (e.g. Tangerine Dream, Optical Race, RCA 2042-2-P).

During the break-in period, the sonic properties of your loudspeakers may undergo several gradual shifts as the various components break-in at different rates. It is therefore suggested that the fine-tuning of the system be delayed until after the break-in period is completed. However, during the final phases of the break-in period, the sonic image will open up, the sound-stage will gain specificity, the bass control and impact will increase, and the overall sound will have a more relaxed, involving presentation.

¹ A high-voltage test is applied to wiring and capacitors during their manufacture. This results in a residual polarization of the dielectric materials.

6 Subwoofer Amplifier

Design Principle

The Sentinel subwoofer amplifier provides essential support for the lowest octaves of the musical spectrum. As a fundamental component of the Sentinel Reference System, the subwoofer amplifier has been specifically designed to match the superlative speed and coherence of the Sentinel's upper frequency response.

The 2400 watt subwoofer amplifier is a push-pull bridged design with fully balanced circuitry. The amplifier utilizes a massive (2 KVA) toroidal transformer and a storage capacity totaling over 70000 uF, with 10 high voltage/current Bi-Polar output devices per channel and discrete high voltage/current voltage regulation. The amplifier has a built-in electronic crossover that is tuned specifically to the subwoofer driver array and box alignment. The result is full-bandwidth low frequency output that has perfect phase coherence down to 16 Hz.

Room Compensation

Loudspeaker positioning within a room dramatically influences sound reproduction quality. In particular, the distances to the room boundaries define a complex system of wave nodes and antinodes that can play havoc with low frequency response and phase characteristics. For example, the reflection from each room boundary (floor, side walls, front and rear walls, and ceiling) creates antinodes when the sound wavelength is about four times the distance to that boundary. The overall effect of these reflections is acoustic room loading, more commonly known as "room boom."

The Sentinel subwoofer amplifier has a sophisticated electronic network that allows for in-room tuning and adjustment that can compensate for this loading effect. We strongly recommend the application of room treatment (See Section 7, Maximizing Performance) before attempting any compensations using the subwoofer amplifier. Once your system and room have been properly set-up and treated, the following procedure can assist you in fine-tuning your system.

1. Set the Master Gain on the subwoofer amplifier (see Figure 6.1) to match the output level of your main amplifier. This adjustment is both equipment and room dependent and should be tuned by ear while performing careful listening tests. Consult your dealer should you need assistance.

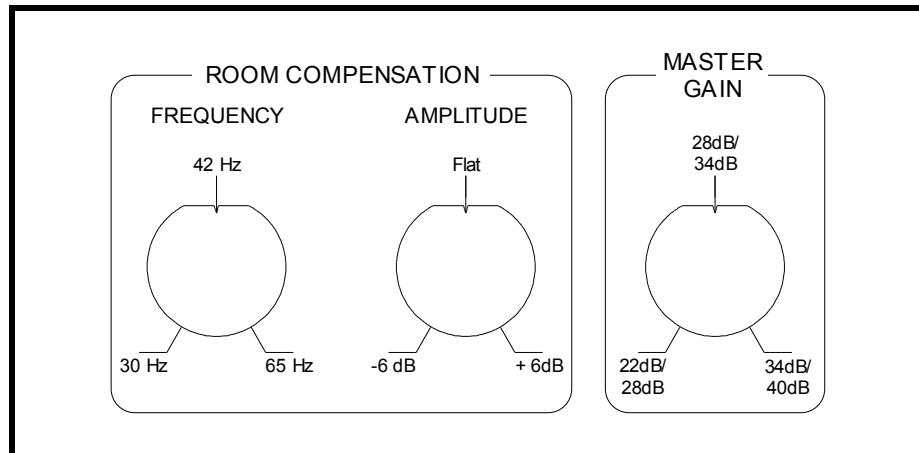


Figure 6.1– Room Compensation and Master Gain controls for the Subwoofer Amplifier.

2. Set the Amplitude control for the room compensation to the minimum setting. This creates a deep notch in the frequency response that compensates for the major room node. This level can be varied after the center "boom" frequency has been determined, for a seamless low-frequency presentation without any dropout.

3. Now adjust the Frequency control for the room compensation to closely match the room node. This is typically found between 42 Hz and 52 Hz. This adjustment is also tuned by ear; listen for maximum low-midrange transparency and speed of the bass response.

4. Now return to the Master Gain control, and adjust it to taste. Again, if you require assistance with this procedure, please consult your dealer.

More refined empirical testing of room boundary effects and low frequency tonal balance requires the use of impulse testing methods. Steady-state sine-wave testing will reveal nothing about the overall in-room performance of the system or comparative compensation methodologies. We highly recommend the Audio Quality Test from Acustica Applicata, at Italian telephone 0583-730322, fax 0538-730914, email: Acustica@forum.lu.it

7 Maximizing Performance

These details are imperative to obtaining optimum results from your Avalon Acoustics loudspeakers.

Break-in

The break-in period is critical to maximizing sonic performance and should take place before other adjustments (see the discussion on page 29). The break-in should begin with three to six hours of quiet music, followed by 200 to 300 hours of loud and dynamic source material.

Separate Left / Right Amplifiers

It is recommended to separate the amplification into left and right channels, by using two mono amplifiers. Separating the left and right channel amplification minimizes cross coupling effects between the channels and provides for better noise rejection, resulting in improved focus, dynamics, and low-level detail. See page 28 (Connecting Speaker Cable to the Amplifier).

Felt Anti-diffraction Masks

The felt anti-diffraction masks are integral elements of the reference system design. Unlike many other products, Avalon Acoustics loudspeakers are designed to be used with the felts in place while listening, and removing them will degrade the system's performance. It is very important that the felt anti-diffraction masks make physical contact with the face of the loudspeakers, as air space between the felt and the speaker face will adversely affect sound quality. Since this is especially important near the tweeter and midrange, applying gentle pressure to the felt near these drivers is recommended. Take care not to damage the transducer diaphragms.

WARNING: The transducer diaphragms are very fragile and are easily damaged. Do NOT touch the diaphragms while positioning and installing felts.

The upper felt is beveled around the openings for the tweeter and midrange drivers. If the felts are removed, be sure to re-install them with the correct inside-outside orientation: the driver openings are beveled on the side that faces the listener (away from the speaker). Figure 3.7 on page 22 displays the proper installation.

Room Treatment and System / Listener Position

Selecting the proper room and listener positions within your listening environment can dramatically improve system performance. The following points highlight the fundamental concepts in room treatment and positioning from the in-depth discussions in Chapter 9, Room Acoustics and Speaker Position (beginning on page 41) and in Chapter 10, Listener Position (page 55):

- Left to right room symmetry aids in producing a balanced sound stage.
- Image depth is enhanced when the distance to the rear wall is increased. This is normally easier to accomplish when the speakers are placed along the short wall of the listening room.
- The side wall and inter-speaker distances can be calculated using the 4 : 10 : 4 ratio.
- The most even bass response will be attained when the distances to the side and rear walls are not overly similar.
- A comfortable, centered listening position at a minimum distance of three meters from the system allows proper wave front convergence.

Toe-In

The exemplary horizontal polar response of the Sentinel Active Reference System makes large amounts of toe-in unnecessary. The optimum toe-in position is between two and three degrees. In situations where strong reflections from the side walls are a problem, pointing the speakers inward up to a maximum of five degrees can be helpful.

Apex[®] Couplers

Supplied with your Avalon Acoustics loudspeakers are twenty Apex[®] couplers, used to couple the speaker and crossover cabinets to the floor, thereby minimizing time-smearing resonance effects. The result is an increase in focus and solidity of the sonic images.

On hardwood floors, use a large coin, such as a quarter, to protect the floor from the pointed spike.

Refer to the set-up procedure in Chapter 3, System Set-up (beginning on page 15) for details of Apex[®] coupler installation.

First Reflection Points

Since the ear/brain system tends to integrate the sounds arriving within a 10 millisecond time window, it is important to control the early reflections arriving from the side walls to the listening position. A hard-surfaced wall can produce a strong frequency-dependent reflection that can interfere with the reproduced sound-stage, as well as change the perceived tonal balance of the system. Therefore, damping these first reflection points is strongly recommended. Please refer to Section 8.3, Early Reflections, beginning on page 45, for further information.

Corner Treatment

It is important to control the corner and wall reflections of low frequency sound. These reflections can cause significant distortions in phase and amplitude, resulting in muddy bass definition, smeared bass transients, and compressed image definition. Placing Tube-Traps (available from Acoustic Sciences Corporation) at the room corners and centered at the walls behind the system and listener can significantly control these bass colorations and restore the quickness of bass transients.

8 Care of Your Avalon Loudspeakers

Cabinet

Avalon Acoustics' hardwood finished loudspeakers are supplied with a special polish and two lint-free polishing cloths, in order to properly care for the high quality furniture lacquer. The following polishing instructions should be observed:

IMPORTANT: Use the supplied furniture polish ONLY. Do NOT use cleaners that contain ammonia, strong solvents, or abrasive materials. Use of these materials can degrade, scratch, or even DESTROY the finish.

1. Apply the supplied polish to one of the clean, lint-free polishing cloths (or use cotton cloth that is clean and lint-free), and carefully wipe it on the cabinet. Be careful NOT to apply the polish to the loudspeaker drivers.

WARNING: Do NOT apply polish to the loudspeaker drivers.

2. Wipe off the excess polish until the desired luster is achieved.

Crossover Cabinet

Your Sentinel crossover cabinets are manufactured with high-density solid surface material. This beautiful finish also requires minimal attention. The cabinets should be dusted with a soft, non-abrasive cloth, moistened with water.

Felt Anti-diffraction Masks

The felt anti-diffraction masks may be removed from the cabinet and gently vacuumed to remove dust. If the felt masks are removed, please note the inside-outside orientation when re-installing the upper felts. The holes for the tweeter and midrange are beveled on the side toward the listener, to provide ideal dispersion characteristics.

Drivers

The drivers (sub-woofers, woofer, midrange, and tweeter) require no regular maintenance. Do not attempt to clean the midrange or tweeter domes, as they are easily damaged. If desired, you may remove dust from the sub-woofer and woofer cones by using a small, soft dusting brush.

9 Warranty

Your Avalon Acoustics loudspeakers are warranted against defects in workmanship and materials for a period of five years, **provided that the enclosed registration card is returned to the factory within seven days of the purchase date. If the registration card is not returned within the seven day period, this warranty is null and void, and you will not be notified of future updates. In the unlikely event that you did not receive the registration card with your loudspeakers, please contact the factory immediately so that we may send you a replacement card.** This warranty is transferable to subsequent purchasers within the original five year period. A complete statement of warranty is given below. Please take the time to fill out and return the enclosed warranty registration card.

In the Event of a Problem

In the unlikely event of a problem with your Avalon Acoustics loudspeakers, the component most susceptible to failure is one of the driver units. If driver replacement is required, have your dealer contact Avalon Acoustics. The performance curves of the drivers in each pair of loudspeakers are kept on file at the factory. This enables Avalon Acoustics to supply an exact replacement unit, ensuring continued operation at the highest level of performance. The defective driver must then be returned to the factory for inspection to determine the status of the warranty claim. This on-site replacement of the driver units eliminates the time and expense of shipping the entire speaker to the factory for repair. **All warranty claims must be made through an authorized Avalon Acoustics dealer or distributor.**

Warranty Statement

1. Avalon Acoustics warrants the materials, workmanship, and proper functioning of this product for a period of five years, **provided that the completed registration card is returned to Avalon Acoustics within seven days of the date of purchase. If the registration card is not returned to the factory within the seven day period, this warranty is null and void.** If any defects are found in the materials or workmanship of this Avalon Acoustics product, or if the product ceases to properly function within the appropriate warranty period from the date of first purchase, the unit will be repaired or replaced by Avalon Acoustics or its authorized agent after receiving authorization from the factory or dealer.

2. Purchaser must return the product, packaged in the original shipping carton, freight prepaid to:

Avalon Acoustics
2800 Wilderness Place
Boulder, Colorado 80301
(303) 440-0422

3. **Avalon Acoustics reserves the right to inspect any products which are the subject of any warranty claim prior to repairing or replacing. Final determination of warranty coverage lies solely with Avalon Acoustics. Any products which do not conform to this warranty shall be repaired or replaced by Avalon Acoustics as soon as possible following receipt of the product and claim, but in no event later than 30 days after receipt of the product. Out-of-warranty claims will be billed for labor, materials, return freight, and insurance as required. Any product for which a warranty claim is accepted will be returned to the purchaser and cost of shipping and insurance will be factory prepaid within the boundaries of the USA. Units to be shipped outside of the USA will be shipped freight collect only. This warranty gives specific legal rights. The purchaser also has implied warranty rights, and may also have other rights which vary from state to state.**

4. This warranty is extended to the purchaser and any purchaser from him for value.

5. Avalon Acoustics strives to manufacture the very finest possible equipment, and therefore reserves the right to make changes in design and improvements upon its products, without necessarily assuming an obligation to retrofit such changes upon its previously manufactured models.

6. The above warranty is the sole warranty given by Avalon Acoustics, and is in lieu of all other warranties. All implied warranties, including warranties of merchantability or fitness for any particular purpose shall be strictly limited in duration to five years from the date of original purchase, and upon the expiration of the warranty period (five years), Avalon Acoustics shall have no further obligation of any kind whether express or implied, including but not limited to merchantability. Further, Avalon Acoustics shall in no event be obligated for any incidental or consequential damages as a result of any defect or any warranty claim, whether express or implied. Some states do not allow exclusion or limitation of incidental or consequential damages or limitations on how long implied warranties last, so the above limitations and exclusions may not apply to you.

7. Avalon Acoustics does not authorize any third party, including any dealer or sales representative to assume any liability for Avalon Acoustics, or make any warranty for Avalon Acoustics. The unit must not have been altered or improperly serviced or repaired. The serial number on the unit must not have been altered or removed.

8. Warranty registration cards must be completed and mailed to Avalon Acoustics within seven days of date of purchase; otherwise, this warranty is null and void. Avalon Acoustics may, at its option, require from the purchaser valid proof of purchase (dated copy or photocopy of dealer's original invoice).

9. If this product is used in a commercial or industrial application, then special warranty exclusions may apply. Contact your dealer or Avalon Acoustics for commercial warranty policies.

10 Room Acoustics / Speaker Position

Introduction

The listening room forms the final link of the playback system, as important as any other component in the chain. Just as an otherwise superb system is handicapped by an inferior pre-amplifier (for example), so can a well-matched system be hindered by poor room acoustics. It is not necessary to listen to your system in a specially-designed sound chamber in order to enjoy it. In fact, a dedicated listening room usually requires additional sound treatment, only due to a lack of other items in the room that can help provide good acoustics. However, a degree of attention to set-up can greatly increase your listening satisfaction, no matter what your listening situation.

Listening in a properly set-up room can be a startling experience. Perhaps it is best described as if the front half of your listening space has been removed, so that the recording site now occupies this part of your room. This can ideally be an entirely three-dimensional space with dense, palpable instruments that are spatially arrayed.

To optimize your equipment set-up and the listening-room acoustics requires a basic understanding of the principles which affect the propagation of sound in the room. Also, we will discuss the way in which our brain interprets spatial cues, and how the room acoustics can affect our sonic perceptions.

An Optical Analogy

Let us use a visual analogy to aid our understanding of acoustics. Imagine that you are in a room that is lit only by a candle in its center. There is (approximately) a uniform amount of light cast in all directions. If a large mirror is held closely to candle, one half of the room becomes darkened, while the other half receives twice as much light. This is because there are effectively two candles now illuminating that half of the room, the real candle, and the virtual (or reflected) candle. The energy that had been sent to both sides of the room has now been concentrated in one side only.

If we repeat the same experiment using a large piece of black cloth instead of a mirror, the results will be somewhat different. The side of the room behind the cloth is darkened, just as before, but the level of light on the side of the candle remains unchanged. This is because the light is absorbed by the cloth, rather than being reflected back into the room.

Thus we can see that the energy can either be absorbed or reflected. A similar situation occurs with sound waves, although we must account for the much greater wavelengths of audible frequencies. Of course no material is a perfect absorber or an absolute reflector. Furthermore, the sonic absorption coefficient of a given material usually varies with frequency.

Basic Room Acoustics

The great majority of all listening rooms are rectangular, with parallel surfaces. The walls and ceiling are typically hard surfaces, which are acoustically reflective. These large areas are the predominating factors in the overall room acoustics, although the other items in the room (furnishings, carpeting, wall hangings, doorways, etc.) will also play a role. Without going into excessive detail, there are four primary areas of potential concern:

- 1. Standing waves.
- 2. Flutter echo.
- 3. Early reflections.
- 4. Bass reinforcement.

The first three items are problems which should be reduced or eliminated. The last item, bass reinforcement, needs to be matched to the entire system for proper tonal balance.

10.1 Standing Waves

The parallel surfaces of most listening rooms can lead to a potential problem at any frequency. A sound wave can be repeatedly reflected from opposing surfaces, back and forth. If the distance between the surfaces is an integral multiple of one-half the sound wavelength, a standing wave will be set up. This means that the incident and reflected waves combine with each other so that a stationary pattern of high and low sound pressures is established in the room. This irregular distribution of sound level is caused by cancellation and reinforcement between the reflected and direct sound waves.

At high frequencies, this pattern of high and low sound pressure levels within the room becomes too finely spaced to be discerned. However, when the dimensions of the room are comparable to the wavelengths of the musical notes, there will be obvious changes in the intensity of certain bass notes in different locations within the room. Additionally, the existence of the standing wave implies a resonant condition where acoustic energy is stored in the room. This energy storage can result in "heavy", "muddy", or "slow" bass.

Since the presence of standing waves is caused by parallel reflective surfaces, practically every listening room suffers from this problem to some degree. However, several factors are working in our favor here. First, as the room size increases, the affected frequencies become lower and thereby less audibly apparent. Second, the presence of shelving or furniture against the walls will break up the large surfaces, reducing the magnitude of the problem. Third, upholstered furniture can absorb a significant amount of bass, diminishing the build-up of resonant energy. Fourth, typical wall construction is not completely reflective at low frequencies.

However, in some cases audibly objectionable standing waves will still be present in the listening room. This can be noted by large variations of the intensity of certain bass notes in different areas of the room. Another indicator is an unevenness of loudness of different bass notes. (This is sometimes what is actually on the recording, so be sure that this is consistently a problem on a variety of recordings, or use a variable warble-tone generator.)

If you wish to reduce or eliminate standing waves that may exist in your room, it will be necessary to reduce the low-frequency reflectiveness of at least one of the parallel surfaces of opposing surfaces. The most effective method is to use Tube-Traps, available from Acoustic Sciences Corporation. This is the only commercially available sound treatment that absorbs significant amounts of energy below 400 Hz. Experimentation will be needed to determine the optimal locations.

10.2 Flutter Echo

These parallel, reflective surfaces can also produce a different audible problem. If there is little absorption at higher frequencies, a musical transient containing high frequencies, such as a hand clap or the strike of a percussion instrument, can be heard bouncing repeatedly between the surfaces. Called flutter echo (or slap echo), these multiple reflections can obscure musical detail. The situation is analogous to standing between two parallel mirrors, when the outline of your reflection becomes more difficult to discern, due to the additional reflected images present.

Again, it is only necessary to reduce the reflectiveness of one of the surfaces in each pair of surfaces to eliminate flutter echo. However, we are also constantly concerned with retaining left/right symmetry in order to maximize imaging quality. Since we are concerned with the high frequencies, any soft material is appropriate. Drapery or fabric wall hangings are quite effective on the walls. Bookshelves also work well by breaking up the flat surfaces. Carpeting should eliminate most potential problems between the floor and ceiling.

10.3 Early Reflections

Another situation that can reduce the subjective quality of reproduced sound is the presence of early reflections. By early reflections, we are referring to reflected sound waves that reach the listener within 10 to 20 milliseconds of the direct signal from the loudspeaker.

When a reflected sound reaches the listener more than 40 milliseconds later than the direct sound, the reflection is heard as a discrete echo. However, if the reflected sound arrives within around 20 milliseconds of the direct sound, the ear/brain system integrates the two sounds so that only one sound is heard. This integration is done in such a way that spatial information is preserved, providing an acoustical "picture" of the physical space that created the reflections.

However, the source recording also contains ambient information that portrays the original recording site. Early reflections in the listening room will tend to obscure the ambient information in the recording, leading to a loss of dimensionality or spaciousness. Secondary arrivals within the first 10 milliseconds are especially problematic, becoming less troublesome as the arrival time lengthens to 20 milliseconds or so.

Avoiding Early Reflections

The speed of sound is approximately one foot (30 cm) per millisecond. Therefore, to preserve the natural sound stage on your recordings, there should be no reflected sounds arriving at the listening position with a path length less than ten feet (3 meters) longer than the direct path from speaker to listener (see Figure 9.1). This means that if the speaker or listener is placed closer than about 5 feet to a wall or other surface, that surface should be covered with evenly absorbent material.

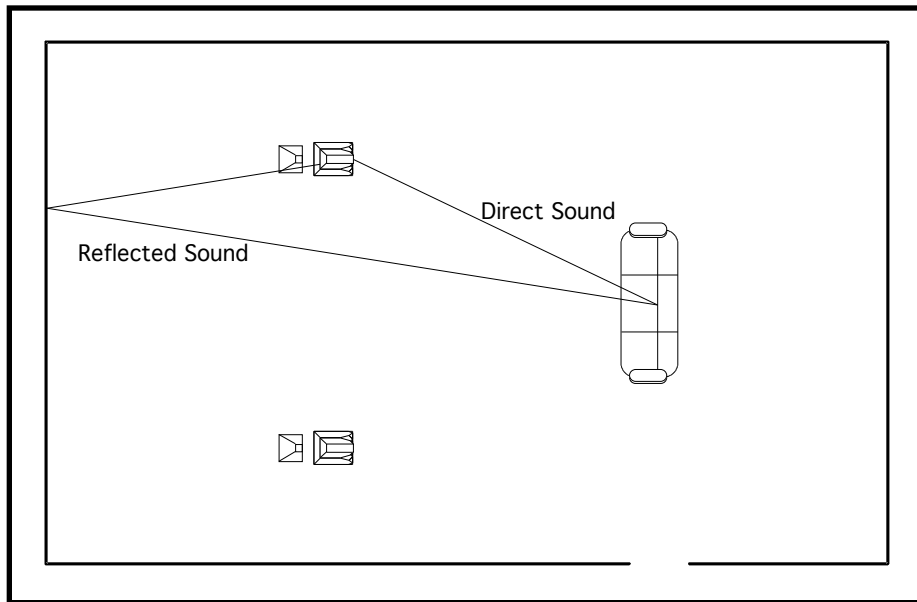


Figure 9.1 - The reflected sound must travel further than the direct sound, and therefore reaches the listener at a later time.

Since the floor is within 5 feet of the speaker, it is best to have a carpeted floor to absorb floor reflections. A thick, dense carpet and pad will absorb lower frequencies more effectively than a thin one. Due to their complex structure, carpets and pads of natural materials, such as wool and jute, exhibit a more uniform absorption over the frequency spectrum than do synthetic materials.

It is not necessary to acoustically treat the entire room to achieve good results. Strategic treatment of specific locations can realize considerable benefits. Remember that when sound waves reflect from a flat surface, the angle of reflection is equal to the angle of incidence, just as a mirror reflects light waves. Therefore, the most important location for sound absorbing material is the point where the sound waves reflect to the listener (see Figure 9.2).

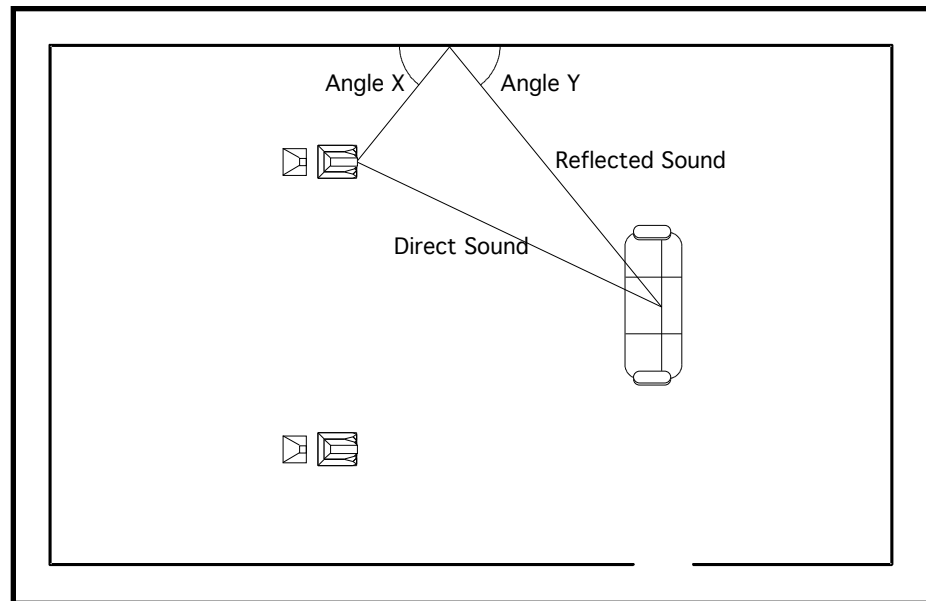


Figure 9.2 The sound is reflected at the same angle that it struck the surface; i.e., $\text{Angle X} = \text{Angle Y}$. Since light waves obey this same rule, a mirror can be used to find the point which can be acoustically damped to avoid early reflections.

Early reflections will tend to diminish the sound stage in the direction of the reflections, i.e. early reflections from the side walls tend to reduce sound-stage width, while early reflections from the back wall will reduce image depth. We have found that a strong sense of depth enhances the feeling of involvement when listening, due to the three-dimensional solidity of images. Therefore, it is more important to have a greater distance from the speakers to the rear wall than to the sides walls. Typically, this is easier to achieve if **the speakers are placed along the short wall of the listening room.**

Low Frequency Reflections

The first significant reflection of low frequency sound waves comes from two corners behind the loudspeakers. Another important reflection occurs on the wall behind the speakers, midway between them. Similarly, low frequency corner and wall reflections take place at the opposite wall, behind the listener. These reflections can cause significant distortions in phase and amplitude, resulting in muddy bass definition, smeared bass transients, and compressed image definition.

Placing Tube-Traps (available from Acoustic Sciences Corporation) at selected locations and orientations in the listening room can significantly control these bass colorations and restore the quickness of bass transients and the depth of sound stage. We recommend placing floor-to-ceiling columns of Tube-Traps at all four room corners, at the wall behind the speakers centered between them, and centered at the wall behind the listener. For listening rooms with low ceiling height, consider treating the wall-ceiling junctions with tube traps as well.

Radial orientation of tube traps is critical. The traps at the wall directly behind the listener, at the wall centered behind the speakers, and at the two corners behind the listener should be placed with their absorptive sides (the side with the seam) facing into the room, parallel with the side walls. The traps at the two corners behind the speakers can be tuned to the listening room, using the following rough guidelines (see Figure 9.3):

- seam toward center of room, parallel with back wall: adds depth to sound stage
- seam away from center of room, parallel with back wall: adds width to sound stage
- seam pointing into corner: sounds livelier, best tonal balance

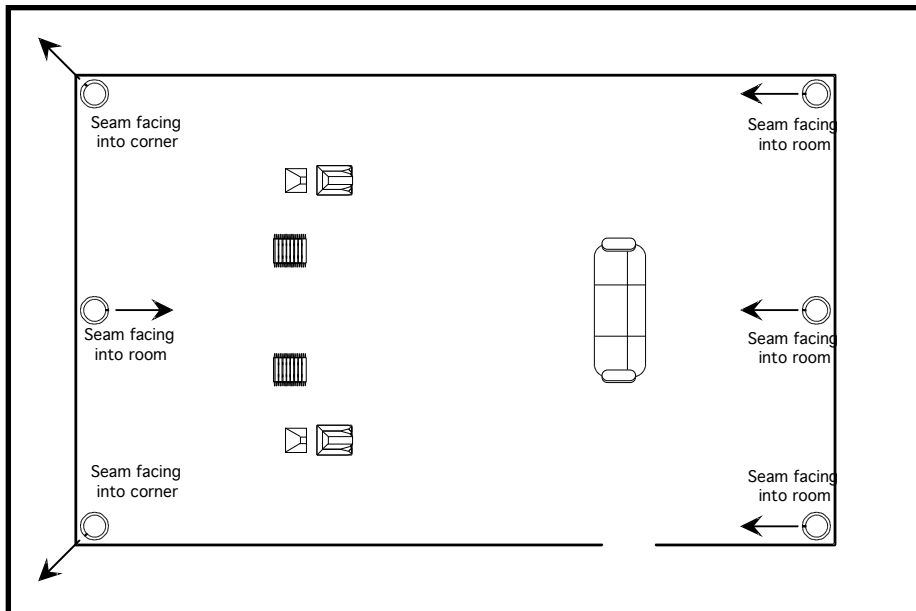


Figure 9.3 – Tube trap placement and orientation. In this example, the tube traps are oriented for best overall tonal balance.

10.4 Bass reinforcement

By bass reinforcement, we mean the effect of the room boundaries on the propagation of sound. It is widely known that speaker placement relative to the floor and walls can affect the relative amount of bass that the system produces.

To make this interaction more clear, let us refer to the optical analogy of the candle. Similar to the way that the mirror reflected the light of the candle, so can the surfaces near the loudspeaker reflect the sound waves back into the listening room. When the wavelength of the sound is large compared to the distance to the boundary, the reflected wave is substantially in-phase with the original wave. When this condition is met, **the coupling coefficient between the speaker diaphragm and the air increases, and the speaker efficiency increases. This changes the actual frequency response of the speaker, and is not attributable to standing waves or other room resonances.**

As frequency increases and wavelength becomes more similar to the distance to the boundary, the phase difference between original and reflected waves increases, and the air coupling effect is diminished. In particular, when the wavelength equals about four times the distance to the boundary, the reflected wave is antiphase to the original wave, resulting in a cancellation (dip) in the output. At frequencies above this level, the effect becomes less significant and creates similar but smaller variations in output. Figures 9.4 and 9.5 illustrate these concepts.

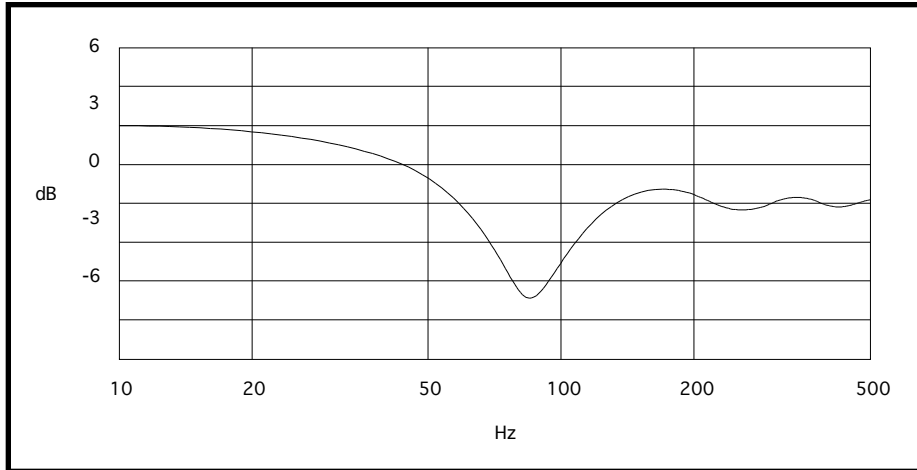


Figure 9.4 - Change in frequency response resulting from placement of speaker 3.3 feet from a reflective surface (relative to an anechoic environment).

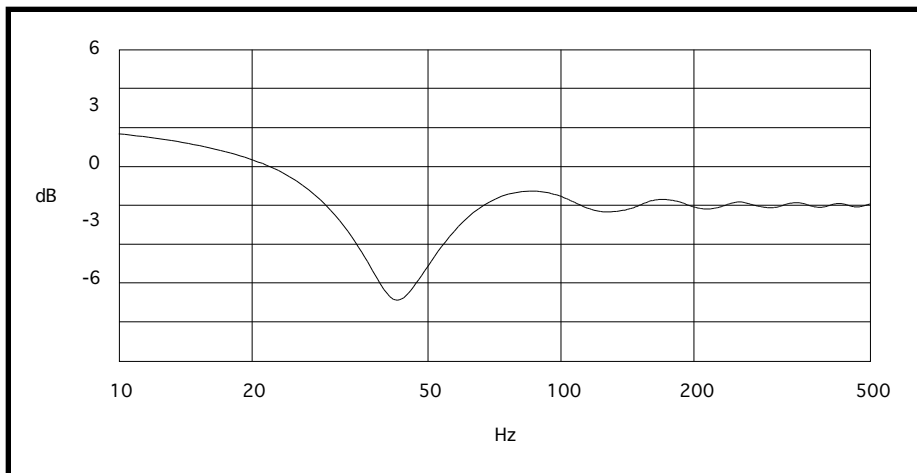


Figure 9.5 - Same conditions as above, except speaker is 6.6 feet from the reflecting surface. Note how the cancellation and reinforcement occur at lower frequencies.

There are typically three reflective surfaces near each speaker: the floor, the rear wall, and the side wall. Each of these surfaces produces its own reflection, and hence its own cancellation and reinforcement. By properly selecting the distances to each surface, we can provide a uniform and extended bass response. Conversely, improper placement of the loudspeakers can result in uneven frequency response, resulting in diminished bass quality.

In order to take full advantage of bass reinforcement and to provide the most uniform and extended bass response, it is recommended that the loudspeaker be placed between four and seven feet from the side wall, and between eight and eighteen feet from the back wall. The measurements are made from the wall to the center of the 9" woofer cone. The exact distances are not overly critical, although the two distances should not be within about 33% of each other.

A good rule of thumb in establishing the lateral position of the Sentinel Active Reference System is to apply the ratio 4 : 10 : 4. In other words, the distance to the side wall is 4/18 (or about 22.2%) of the room width, and the distance from speaker to speaker is 10/18 (or about 55.5%) of room width.

10.5 Summary of Recommendations

Now that we have looked at some of the common problems of listening rooms, as well as their cures, let us summarize our findings and recommendations.

Flutter Echo and Standing Waves

These situations are the result of the room having parallel, reflective surfaces. The potential problems are independent of the audio system, and need to be addressed at the source. This means that at least one surface in an opposing pair of surfaces needs to be made less reflective and/or non-parallel.

- Low Frequency Absorption

If a problem exists with standing waves, it is the low frequencies that will need to be addressed. Remember that the absorption spectrum of different materials and objects is not uniform. That is, some items will absorb only high frequencies, and some objects may only absorb the middle frequencies. At low frequencies, about the only common item that can absorb a meaningful amount of energy is heavily upholstered furniture. Another effective means of absorption is the use of Tube-Traps, from Acoustic Sciences Corporation.

- High Frequency Absorption and Room Symmetry

Since flutter echo is a high-frequency effect, it becomes much easier to manage potential problems in this area. Almost any item attached to the walls will be less reflective at high frequencies than the bare walls themselves. Draperies, wall hangings, paintings, bookshelves and other items will normally be present in the room, and will usually eliminate any possible problems. If flutter echo is still audible, a fabric wall hanging provides an effective and attractive cure.

Additionally, it is desirable to maintain a degree of left/right symmetry in the room to preserve a balanced acoustic "space." For example, if your listening room has full length draperies along the right wall, and the left wall is bare, slap echo will not be a problem. Nonetheless, the sound-stage may be somewhat distorted, and it could be beneficial to place a fabric hanging or tapestry on the wall opposite the draperies.

- Parallel Surfaces

Although it is not generally possible to make the walls non-parallel, the same effect is achieved by breaking up the large, flat surfaces with furniture and shelving.

Early Reflections

When arranging the furnishings in your listening room, remember that reflective objects should not be within a five foot radius of either the speaker or listener to avoid early reflections. This suggests the possibility of a dual-purpose room, with one end devoted to music reproduction, and the other end for another use, such as a study or office. In this way, the area behind the listener will contain items that will reduce problems with standing waves and/or flutter echo, while the zone around the speakers remains relatively free from reflective objects.

If you wish to achieve an even more spacious sound-stage, it may be useful to place a sonically absorbent material on the side and rear walls near the speakers. This can be particularly effective at the points where the sound wave is directly reflected to the listening position (a mirror can be used to determine these points, as illustrated in Fig. 9.2). As the distance to the wall becomes smaller, the suppression of these reflections becomes more important.

In order to enhance the sound stage depth (and hence the feeling of musical involvement), it is important to have a greater distance from the speakers to the rear wall than to the sides walls. This is generally easier to achieve if the speakers are placed along the short wall of the listening room.

Speaker Placement

Although the Sentinel Active Reference System may be placed in a variety of positions relative to the walls of the room, it is still wise to apply the basic guidelines described in this chapter to achieve optimal results. Plan on placing the speakers along the short wall of the listening room. Then apply the 4 : 10 : 4 ratio to establish the side wall distance (see page 51). The rear wall distance should be greater than and not overly similar to the side wall distance.

The suggested minimum distances for the Sentinel are 4 feet from the side wall, and 8 feet from the rear wall (all distances are measured to the center of the 9" woofer cone). This will provide the proper degree of bass reinforcement, as well as minimize early reflections. There is no suggested upper limit for the distances to the walls. Even a distance of 10 feet to one wall and 15 feet to the other wall will provide suitable bass reinforcement, and problems due to early reflections will be non-existent. However, regardless of the absolute numbers used, the most even bass response will be attained when the distances to the side wall and the rear wall are different by at least 33%.

The exemplary horizontal polar response of the Sentinel Active Reference System makes large amounts of toe-in unnecessary. The optimum toe-in position is between two and three degrees. In situations where strong reflections from the side walls are a problem, pointing the speakers inward up to a maximum of five degrees can be helpful.

10.6 A Listening Room Example

In order to make these points more clear, an example of a room layout is given in Figure 9.6, illustrating the principles we have given.

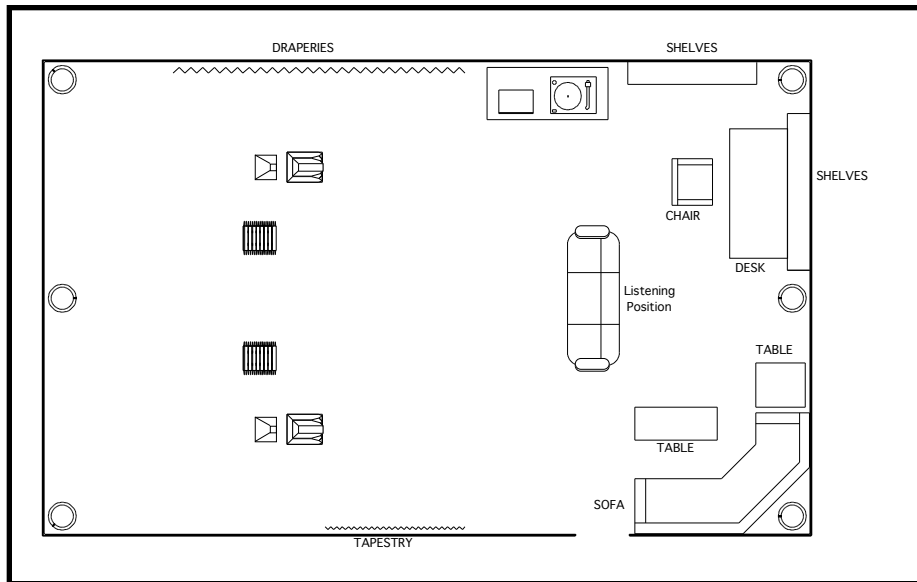


Figure 9.6 - Example listening room. The area around the speakers is free of any object that would produce early reflections.. A tapestry is hung opposite the draperies to absorb the reflection from the side-wall and to help maintain left-right symmetry. The area behind the listening position contains items which help break-up standing waves and flutter echoes. Heavily upholstered sofas will help avoid low-frequency standing waves, while a carpet absorbs early reflections from the floor. Tube traps are placed in the corners, centered at the wall behind the speakers, and centered at the wall behind the listener.

11 Listening Position

Just as loudspeaker positioning and room treatment can address the issues of standing waves, flutter echo, reflections, and bass reinforcement, careful attention to listening position is crucial to achieving accurate sound stage placement, tonal balance, harmonic structure, focus, and image size. In order to fully benefit from the Sentinel Active Reference System's outstanding resolving potential, one must consider the three dimensional location of the listening position in relation to the system and room.

Path Length Symmetry

In the previous chapter, it is recommended to maintain left/right symmetry in the listening room to preserve a balanced acoustic "space." Similarly, if the listening position is severely off to one side, there will be a significant difference in the path length of sound emanating from the loudspeakers. The resulting time differential will disturb the overall left/right balance and cause a phase shift in the information coming from one channel relative to the other channel. Depending on the frequencies involved, some sounds will arrive at the listener's ear to some degree out of phase and cause cancellations or drop-outs in the frequency spectrum. Therefore, it is important to maintain a listening position that is reasonably symmetric to the room and centered between the loudspeakers.

Time Alignment

The front planes of the Sentinel Active Reference System have been carefully sculpted to establish accurate driver time alignment. In Figure 10.1, notice that the acoustic centers of the drivers are situated so that the wave front converges precisely at the listener's ear. In order to achieve this convergence, it is recommended to place the listener in a comfortable chair or sofa with the listener's ear about 110 cm above the floor and a minimum of two, and preferably three meters or more from the system.

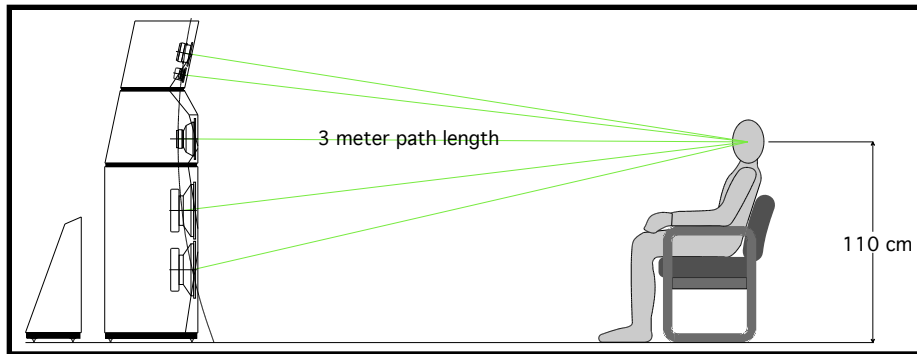


Figure 10.1 - Convergence of the wave front occurs with the listener ear situated approximately 110cm (43 1/2") from the floor and a preferred minimum of 3 meters (118 inches) from the system.

Summary

When the listener and system are situated properly within a carefully planned and set-up listening environment, the Sentinel multi-way system can deliver high-energy output with point-source accuracy. It is crucial to begin with a relatively large room that is acoustically treated reasonably and to follow the set-up guidelines detailed in Chapter 9, Room Acoustics and Speaker Position. The listener should be seated in a comfortable chair or sofa that is centered between the loudspeakers. At the preferred minimum distance of three meters from the system (the edge of driver wave front convergence), you can expect a natural stage presentation and realize the Reference System's potential for outstanding clarity and focus. On certain multi-miked recordings however, the high frequency information may appear slightly elevated within the sound stage. At four meters, the energy fields begin to blend more integrally and tonal balance becomes more correct. The image focus and size as well as the overall harmonic structure is improved, and the music integrates into a coherent whole.

12 Accuracy of Bass Reproduction

Introduction

We have all had the experience of listening to speakers with poor bass quality. Perhaps the bass was muddy, or ill-defined. Possibly the bass was exaggerated or bloated. In any case, these type of distortions are distracting and can keep us from enjoying the full measure of the performer's intent.

When it comes to the reproduction of low frequencies, Avalon Acoustics pursues a different design goal than most other manufacturers. Specifically, we believe that the complete absence of stored resonant energy is of paramount sonic importance. First, we will discuss some of the technical aspects of bass reproduction and perception, and then explain how this relates to the listening experience.

12.1 Sensitivity to Time-Related Information

It is widely known that the human ear/brain system is extremely sensitive to time-related distortions. This can be understood when one realizes that directional and spatial information is provided by inter-aural time (and phase) differences. During the period of man's evolution, the ability to accurately determine the direction and distance of sound sources conferred a decided survival advantage, hence our present day aural sensitivity to time-related information.

This sensitivity to time-related information can be observed when listening to audiophiles discussing the quality of a system's bass reproduction. Many of the terms refer to temporal properties. A system with poor transient bass response is described as "boomy", "heavy", "**sluggish**", or "**slow**". When the transient response is accurate, the bass is characterized as "tight", "clean", "**quick**", or "**fast**".

"Fast Bass"

The term "fast bass" would seem to be an oxymoron on the surface. After all, it is the "slowness" of a note that makes it a low frequency. Nonetheless, the term provides an accurate description of our subjective impression. Many people have erroneously ascribed "fast bass" to the use of a light diaphragm or the use of a powerful energizing system.¹ In fact, it is not how fast the diaphragm can be set into motion that imparts a speaker with "fast" bass. Rather, it is how fast that motion can be **stopped**, how quickly the stored energy can be dissipated, that results in the sensation of "fast" bass.

¹ The acceleration of an object is equal to the force exerted upon it, divided by the mass of the object. Since a loudspeaker is used above its fundamental resonance, it operates in what is known as the mass-controlled region. In this region, high acceleration (large driving force and/or small driven mass) does not imply extended high frequency response or fast transient response. Instead, high acceleration confers high efficiency.

12.2 Measurements of Audio Equipment

It should be recognized that measurements are not the final arbiter of sound quality of audio components. Often times a measurement standard has evolved because it is easily performed, or because it is easily repeatable, or it has shown some link to certain audible characteristics. Unquestionably, it is the latter criterion which is the most important one. After all, the listener is not concerned with how a piece of audio equipment measures, he is only concerned with the faithful recreation of the original musical event.

On the other hand, measurement techniques that correspond to audible effects are an invaluable tool to the designer. However, it is the degree of correlation with the subjective experience which is important, and anechoic bass response does not have a high correlation with musical accuracy in the listening room. In-room frequency response and transient accuracy are both significant factors in determining subjective quality. Nevertheless, anechoic frequency response is by far the most prevalent measurement used to characterize speakers.

A Correlation with Amplifier Measurements

A striking parallel exists in the measurement of audio amplifiers. The power output and distortion of an amplifier is invariably measured into an eight-ohm resistor. It is widely acknowledged that this standard is far removed from the actual conditions in which the amplifier will be used. One doesn't listen to resistors, one listens to loudspeakers, and the load that the speaker presents to the amplifier is nearly always highly reactive (varies with frequency). The eight-ohm resistive load has developed as a standard because it somewhat approximates a speaker load, is easily reproducible by different testing facilities, and it represents something of a lowest common denominator. That is, while everybody recognizes that a different load should be used for amplifier testing, nobody can agree as to what that alternative should be.²

In the last decade, there has been a growing awareness of the importance of an amplifier's capability to drive a real-world loudspeaker. This is the reason we have seen the emergence of amplifiers with high current output capabilities, and a lack of current-limiting or similar protection circuitry. The ability to drive reactive loads has been accepted as having a higher correlation with audible qualities than the traditional measurement into a load resistor.

² The cynic will also note that a resistive test load produces the most impressive measurements for use in advertisements.

Loudspeaker Measurements

Returning to loudspeakers, a similar situation has developed. Although nobody listens to music in an anechoic chamber, loudspeaker measurements are commonly performed in them.³ Although various proposals have been made for performing low frequency measurements in a more realistic setting, there has been no agreement as to what that setting should be. Loudspeakers continue to be measured in a test chamber that is equivalent to the **absence** of any room at all.

There is a developing appreciation that this traditionally performed measurement is not an accurate predictor of the performance actually attained in the listener's room. Certainly, in-room frequency response is more important than anechoic response in determining a speaker's tonal accuracy. Placement of the speaker within a room will cause changes in the frequency response compared to the anechoic condition.⁴ At lower frequencies, the speaker's output is modified by the acoustic loading presented by the walls and floor. However, when making measurements, it is difficult to separate the effects of a room's bass reinforcement from standing waves and other resonances associated with that room.

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- ³ Since an anechoic chamber which performs accurately to low frequencies is extremely large and expensive, other measurement methods are also commonly used. These include near-field measurements, when the microphone is extremely close to the driver, and half-space measurements, when the speaker under test is buried with its front baffle flush with the ground, facing upwards. Both of these methods are equivalent to anechoic measurements below the frequency at which the speaker baffle appreciably changes the acoustic load to the woofer, typically between 100 and 200 Hz. Note that these conditions are also non-representative of an actual listening situation.
- ⁴ Since this discussion is concerned with the reproduction of low frequencies, we will not delve deeply into the high-frequency variations between the anechoic response and the in-room response of a loudspeaker. Briefly, the interaction of the dispersion pattern of the speaker with the reflective surfaces in the room (and the variation of both with frequency) creates an in-room frequency response that may vary markedly from the anechoic response.

Designing for Accurate Bass Reproduction

How, then, does one arrive at the goal of a loudspeaker that provides tonal accuracy in the listening room? The answer, in large part, comes in the form of the digital computer. It is possible to create a mathematical model of a listening room, and predict the response of a given speaker in that room. With the computer model, it is quite easy to change the position of the speaker in the room, or other parameters of the model. In this way, a composite picture can be created of a wide variety of rooms and speaker locations. This enables one to design the speaker so that it interfaces properly with the listening environment and provides correct bass response in real-world environments.

The accuracy of the computer model must also be tested in the physical world, using pink noise, warble tones, and time-delay spectrometry for verification. The final, and most important check, is the listening test. Theory and measurements become useless if they do not agree with what our ears tell us. Even the best measurement methods provide little more than a simplified, one-dimensional translation of what is, in reality, an extremely complex, multi-dimensional experience. Again, the goal is the recreation of a musical event, and the faithfulness of that recreation can only be determined through listening.

12.3 Listening Qualities

Now we will turn our attention to the listening experience, and describe how these measurable properties correlate with our subjective impressions.

There are two main factors which affect subjective low-frequency accuracy, frequency response and transient response. At low frequencies, these two descriptions are different aspects of the same event.⁵ Nevertheless, for the purposes of this discussion, we will treat these two topics separately as much as is possible.

Frequency Response Effects

As you listen to music, images of the instruments that created the sounds are elicited. For instance, one can tell the approximate size of a drum from the sound it produces. On a high-resolution playback system, finer details can be heard; i.e., is the head made of plastic or calfskin? Is the player using light sticks or heavy ones?

A relatively broad-band emphasis (or de-emphasis) of a given frequency range can tend to exaggerate (or diminish) the relative size of the instruments playing in that range. A useful tool for evaluating these distortions of size is a recording of a small group of unamplified acoustic instruments made with a simple microphone set-up. One superb example is the series of acoustic jazz recordings available from Chesky Records. These are made with a single-point stereo microphone, and feature a photograph of the recording session that shows the location of the players.

Listening for Size Distortions

Play a recording of this type, with the volume adjusted to achieve a natural playback level. As you listen, create a mental image of the players based on sounds being recreated. Then ask yourself, "Does this sonic image correspond to the musical instruments that generated these sounds?"

Is the portrait a natural one, or are certain elements distorted? Does a stand-up bass sound like the correct size, or is it exaggerated, sounding like it is ten feet tall, or as if the strings are the size of ropes? A speaker with excessive in-room bass response can create these effects. On the other hand, a speaker system with rolled-off bass can shrink the size of instruments, turning the same stand-up bass into a cello-sized instrument.

⁵ Below about 200 Hz, virtually every woofer operates as a minimum-phase device. This means that the responses in the time-domain and the frequency-domain are inextricably linked, and that the one generates the other. Thus, two woofers with the same frequency response will necessarily exhibit the same time (phase) response. However, many crossover networks display non-minimum phase response, and will thereby alter the phase response of the woofer in the speaker system.

Transient Response Effects

A speaker with poor transient response will store energy, releasing it after the initial musical transient has passed. This causes a loss of detail and obscures important musical information. Also associated with poor transient response is a narrow-band resonance, which can emphasize specific notes.

When listening for the low-frequency transient accuracy of a speaker, it will be useful to utilize a broad variety of recordings. Try playing a rock or jazz group, and listen to the interplay between the drummer and the bassist. Is it easy to distinguish the kick drum from the bass, or is there a blurring of low-frequency detail caused by the speaker's time-smear?

To listen for narrow-band low frequency resonances, use a recording with the bass line played by a synthesizer. As you listen to the bass line, are the individual notes of equal level, or are some of them more prominent than others? Electronic instruments can be more useful for this test since acoustic instruments have resonances of their own which can hide flaws in the speaker, unless you are intimately familiar with the instrument and the recording. Similarly, an electric bass that has been recorded by miking its speaker/amplifier will exhibit the resonances of its speakers, which are inevitably considerable, masking defects in the loudspeaker under evaluation.⁶

⁶ There is a technique known as "direct injection" where the signal from an electric instrument is connected directly from the amplifier to the recording console, bypassing the speakers. In this instance, an electric bass will prove to be a consistent low-frequency source. The difference between direct injection and miking of the speaker/amplifier is easily audible with high-quality speakers.

12.4 Active Subwoofer System

Designing a loudspeaker system for accurate low-frequency reproduction is a challenging proposition. Given a reasonable listening environment, there is very good correlation between the anechoic and in-room responses at frequencies above 350 Hz. However, at low frequencies, boundary effects come into play, significantly altering the in-room response.

Anechoic Frequency Response vs. In-Room Frequency Response

It must be remembered that very little listening actually takes place in anechoic chambers. Placement of the speakers in a real-world listening room will boost the bass response of the speaker, as explained in Section 8, Room Acoustics and Speaker Position, beginning on page 41.

Active Control of Bass Energy

In order to properly control the bass energy and achieve a flat frequency response in-room, the Sentinel Active Reference system employs an active, powered subwoofer system. The subwoofer amplifier is specifically designed to handle the high-power demands of low-frequency signal, via the amplifier's massive toroidal transformer, exceptional storage capacity, and unmatched high voltage/current regulation.

The Sentinel Active Reference System's high-capacity subwoofer amplifier handles the most demanding low-frequency passages and actively controls and maintains transient speed and accuracy. Coupled with the dual-driver ultra-lightweight diaphragm subwoofer section, Sentinel produces deep, accurate bass down to 16 Hz, with complete freedom from stored resonant energy.

13 Features

- Application of new cabinet research features nineteen separate aperiodically damped internal chambers in three distinct speaker cabinets for superior resonance control.
- Advanced light weight driver diaphragm materials minimize energy storage and time-domain distortion.
- High-definition tweeter and midrange have ultra-light concave ceramic dome diaphragms.
- Extremely stiff and light Nomex-Kelvar Woofer and Subwoofer cones provide unmatched stiffness and high energy transient accuracy.
- Each driver individually tested and matched for optimum performance.
- Moderate impedance characteristic allows for ideal interface with any amplifier.
- Star-grounding techniques eliminate signal modulation.
- Crossover circuitry is hard-wired with surface-only conductors, eliminating deleterious sonic effects of printed-circuit boards.
- Exceptionally low noise, highly reactive induction technology reduces inter-driver jitter, resulting in state-of-the-art micro-dynamics.
- Direct harness wiring to drivers, with oversize barrier strips and screw terminals at crossover connections for maximum signal transfer.
- Crossover elements meticulously oriented to minimize interaction of magnetic fields.
- Polypropylene and coaxially wound polystyrene capacitors used exclusively to minimize energy storage.
- Newly developed proprietary damping circuits control each driver's electrical parameters, reducing interaction with the amplifier.
- Crossover circuitry housed in a rigid external enclosure, providing maximum isolation from vibrations.
- Constrained-mode damping in golden section laminations absorb cabinet vibrations.
- Six-inch thick front panel supplies acoustically inert wave-launch platform.
- Acoustically-engineered beveled anti-diffraction felts minimize reflective and diffractive effects.
- Distinctive faceted cabinet design provides optimal polar characteristics.

14 Specifications

Loudspeaker

Driver Complement	1" concave ceramic dome tweeter 3_" concave ceramic dome midrange 9" Nomex-Kevlar composite cone woofer Two 13" Nomex-Kevlar composite cone subwoofers
Sensitivity	88 dB (2.83V, 1 meter)
Impedance	4 ohms nominal (3.6 ohms minimum)
Frequency Response	16Hz to 34kHz (+/- 1 dB, anechoic)
Recommended Amplifier Power	100 to 1000 watts
Wiring Methods	Two position terminal block, designed to accept spade lugs for #10 screws.
Dimensions	Overall height: 69 inches (1.75 meter) Overall width: 17 inches (0.43 meter) Overall depth: 37 inches (0.94 meter)
Weight	910 pounds (415 kg) crated system (not including sub amps)

Subwoofer Amplifier

Frequency response:	16 Hz to 100 Hz +/- 0.1 dB
Sensitivity:	1.3 Volts in for rated output
Input Impedance:	16 K ohms
Gain:	Adjustable 24 - 34 dB
S/N Ratio:	135 dBR
THD+N:	0.002%
Rated Output:	2400 Watts per channel
Dimensions:	19" w x 19" d x 9" h (48cm x 48cm x 23cm)
Weight:	120 lbs each (55 kg each)

15 Notes
